Petroleum Today

IN THIS ISSUE:

Halfway to the Moon—On Wheels
by Robert L. Heilbroner

Mr. DE and His World
by Norman Cousins

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COVER COMMENT

Our readers are at liberty to title the cover what they will. Our choice is "Spring Fever."

Halfway to the moon— on wheels

by Robert L. Heilbroner

From the earth to the moon it is 238,000 miles as the rocket flies; to the sun it is some 92½ million more. Out to the very rim of the solar system it is nearly 4 billion miles; once around the system itself is about 22 billion miles. That gives some indication of what *seven hundred billion* miles means, particularly if you can imagine such a distance being folded up inside a container as small as the map of the United States.

Yet 700 billion is the mileage clocked last year by the American people as they drove their 70 million cars, trucks, buses, jeeps, ice-cream wagons, bookmobiles and hot-rods to work and to play, on missions of life and of death—or just around the block looking for a parking space.

The statistics of the automobile are all astronomical. If you take that favorite statistician's device and put our cars bumper-to-bumper, you get a string of vehicles that would itself reach halfway to the moon. If you take the amount of money laid out for the purchase and operation of our automobile armada you get a sum larger than the combined national incomes of Canada and Mexico. Or if you simply take the amount of love and hate, care and carelessness, pride and perspiration evoked by the Car, you get something which, however unmeasurable, is nonetheless recognizable as an integral part of our national character.

Yet all these images at best only indicate in a vague way the most important fact about the car. This is the truly astonishing degree to which it has imposed its stamp on the society which created it. Having set out to do no more than make a practical machine for moving people and things about, the auto manufacturers set in motion a device which quite literally revolutionized our environment. In a single generation the automobile evolved from an extravagant plaything which Woodrow Wilson singled out as an example of the "arrogance of wealth," to a ubiquitous possession in which, as Will Rogers quipped in the 'thirties, we would be the first people in history able to ride to the poorhouse.

We are all aware in a general way of this pervasive "automobilization" of the economy. Yet it is a curious fact that when we picture the economic implications of the car, we almost always think on much too small a scale. Mention the automobile, and we immediately conjure up Detroit as the "automobile capital" of the world. Yet Detroit is in fact only the hub of a manufacturing operation half of which is to be found in 24 scat-

tered states outside of Michigan. Similarly, when we think of car production the names of three or four giant corporations come to mind—but there are also at least two thousand other firms engaged in car production as subcontractors or as suppliers of special parts. Or else we concentrate our attention on the industry as a *producer* and forget that it is also a voracious *consumer*—the biggest single buyer of sheet steel, zinc, lead, rubber, leather; the customer for one out of every three radios produced in the nation; the purchaser of 50-odd million sealed-beam lights, 24 million gallons of paint, 25 billion pounds of chemicals. Even more interesting, it is—or at least it was until the day of the ICBM—the largest single user of engineering talent in the country. One-sixth of all patents issued in the U. S. have to do with the production or design of cars.

Yet even when we widen the lens aimed at automotive manufacture, we miss the full picture of the economy on wheels. For the real impact of the car is not to be found in "Detroit" at all. Big as it is, the whole production force making motor vehicles is only one per cent of our total labor force, and no more than five per cent of our manufacturing labor force. For all the fact that automobile manufacture is the largest single industry in the nation, its total output amounts to no more than three per cent of our Gross National Product.

To appreciate the full extent of our automobile economy we have to turn our attention to what happens *after* the vehicles bump down off the assembly lines. It's when we trace the impact, not of the 6 million or so new cars, but of our 70 million full complement of motor vehicles, that the importance of the automobile in our economic life begins to be clear. For then we find that no less than one out of every seven American jobs, and one out of every six businesses, depends on the car. In all, some 10 million Americans owe their livelihood directly to the omnipresent automobile.

Much of this tremendous impact of the automobile on our economy comes from the "handmaiden trades" which it has called into being. To maintain, support, repair and propel America's 70 million motor vehicle pool requires a whole cluster of automotive service industries. There are, for example, about 200,000 service stations, which pump the 60 million gallons of gas annually, needed to make the fleet go. There are about 43,000 car dealers to put new and used cars into circulation, and 25,000 car wreckers to consign them to scrap, and thence via the steel mills to rein*car*nation. There are 79,000 repair shops to tend to the more serious complaints among the 60 million annual emergency road calls; 6,250 parking lot operations to shoehorn cars into profitable bits of cindery space, and 1,600 auto laundries to wash the cinders off when the cars emerge.

But these are only the immediate servants of the automobile and the truck. Even more important are a whole series of secondary industries, no one of which sells a product to be used directly by the car itself, but all of which would expire miserably should the wheeled economy stop rolling. These are the industries which capitalize on America's *mobility*—on the fact that because of the car the average family covers nine times the distance today that it did in 1900.

Largest of these indirect beneficiaries of the car is the travel industry. "Once only a privileged few had gone to Newport for bathing and Pasadena for winter sunshine," writes historian Allan Nevins, recounting the influence of the automobile on American life. "Now millions went wherever they pleased." And Nevins was referring to the 1920's when auto registration was only a third of that today and when the travel impulse was still quiescent. Last year over 66 million Americans took off for vacation in their cars, with the result that tourism today ranks among the top three industries of over *half* our states. Americans no longer live by taking in each other's washing, but by taking in each other's scenery, beach, plum preserves, and souvenirs.

One result of this travel boom has been a revolution, in the ancient trade of hostelry. There was a time, not so very long ago, when a village of 1,500 souls was deemed large enough to warrant a small inn, if only to shelter the weary drummer. The coming of the car killed that, as the drummer preferred to shove his bags onto the back seat and push on to the big city only 50 miles down the road.

But having killed the inn, the mounting flood of traffic now threatened to strangle the big city hotel. So hotel and inn met halfway in the new

concept of the motel. Already by 1922 there were 600 of the new "tourist courts"; by 1940 there were 13,000 of them. Today the number approaches 60,000 and their volume of business has reached the staggering—but by no means ceiling—figure of $2.2 billion. There is perhaps only one evolutionary step left—to put our cities on wheels. It is a step we have already begun to take: our trailers, if grouped together, would form America's sixth largest city, with a population of 1,850,000.

Meanwhile, the mobile dollar is forcing a change which cuts even deeper into our economic pattern of life. This is the new channels into which it is directing the distribution of goods.

Trucking is of course the prime example. Today rail transport has become the great bulk cargo carrier; air transport flies in the small, high value stuff; truck transport moves all the rest. Fifty-nine thousand fleets of trucks—counting only fleets with ten trucks and up—shuttle 76 per cent of the nation's total freight tonnage.

But aside from the trucking revolution, the car itself is imposing its imperious demands on merchandising. If you want to sell goods these days you have to put them where you can get *to* them by car, and preferably where you can get *at* them without even leaving your car. Thus the shopping centers, mushrooming at the crossroads, are steadily displacing the traditional downtown areas as the nation's favored retail locations. And thus, too, the "drive-in" is taking the place of the retail counter itself. In ancient times merchants humbly spread their merchandise before the potentate lounging in his palanquin; in modern times as we make bank deposits, borrow and return books, order groceries, view movies and eat pizza pies without having to leave our mechanized palanquins, we seem to be recapturing the languor, if not quite the splendor, of the antique potentate.

Yet these reflections on the impact of the automobile still fail to do justice to its quintessential contribution to our lives. This is its gift of mobility itself—not mobility as a dollar-spreading device or as a mechanical substitute for personal movement, but as a direct enhancement of life, as an enlargement of life's boundaries and opportunities. This is so enormous, so radical a transformation that its effect can no longer be measured or appreciated by mere figures. It is nothing less than the unshackling of the age-old bonds of *locality*; it is the grant of geographic choice and economic freedom on a hitherto unimagined scale.

We can do no more than point in the general direction of the changes which mobility has wrought. We see it in the breakdown of the old factory town where workers perforce dwelt in the shadow of the mills and plants: today seven out of ten workers drive their cars regularly to work —and are thereby free to live in residential rather than industrial areas. We see it in the proliferation of suburban life, a development impossible without mass automotive transportation. We see it in the great currents of internal migration, in which one family in every five changes its address each year in search of a better job, a better home. What this has meant, not alone in terms of wider economic horizons, but in terms of wider life horizons is incalculable.

As with all great technological transformations, however, the automobile revolution has not been painless or without its costs. If the car has given a new dimension to life, so has it also added to the chances of death: double the number of people have been killed and 26 times the number wounded by automobiles than by all the wars in which we have ever fought. Similarly, if the car has given us mobility, so too has it bequeathed us its own peculiarly irritating form of immobility—the traffic jam. And if the car is the family chariot, its shopping bag and its umbrella, so also is it the agent of the clutter of the emporium highway.

More serious is the fact that in its very virtuosity as an expenditure-creating device, the automobile implies dangers as well as obvious benefits. Many economists are concerned at the effect on our overall economic stability of a typical hell-for-leather auto production effort—followed by an equally typical letdown when dealers find themselves overstocked. Still other observers question whether the average American family may not tend to spend too much on fancy and overdecorated cars to the detriment of such unglamorous possessions as medical care or adequate insurance.

These are real costs to be taken into account when we seek to assess the im-

pact of the automobile on our lives. Yet they are at most a large discount and not a cancellation of the gain which automobiles have brought. However dangerous, foolish, expensive, troublesome and inconvenient the car may be, all these demerits are far overshadowed by one consideration: The automobile has become indispensable.

Every indication points to the conclusion that it will become even more inseparable from our way of life. Our automotive flotilla grows steadily; by 1975 it will number 111 million vehicles. The web of transportation is growing more complex, more all-encompassing; the pace and reach of our automotive mobility is increasing yearly.

What ultimate effects, good and bad, this growing automobilization of our economy may bring, no one can clearly foresee. What is certain, however, is that the progressive dependence of our economy on the car will pose two major problems over the coming years.

One of these is traffic congestion, particularly in urban areas. There is no easy solution to this problem, for more is involved than difficult questions of traffic engineering. At least as important is the "financial engineering" which sets the pace and determines the limits of our highway program. Today that financial approach is far from constructive in many respects. On the one hand, we tend to restrict highway construction to those funds raised by highway taxes and tolls—even though our road network brings vast economic benefits to non-motorists as well. On the other hand, the federal government sidetracks 40 cents out of every dollar received in special taxes on the motorist into the Treasury's General Fund—while in many states also we allow as much as 20 to 30 per cent of highway revenues to be used for non-road purposes.

Thus to some extent we use our highway traffic as a means of generating general fund revenue but we fail to view the highway system itself as a general national asset on which non-highway revenues may legitimately be expended. In other words, we are still looking at our road system as something which can be viewed apart from the economy as a whole rather than as the foundation for our economy on wheels.

Equally important as an adequate supply of highway space is a second problem—the assurance of adequate and economical supplies of fuel. The average car owner today spends about $275 annually for gas and oil—of which $75 is not for fuel, but for the taxes which come with it. Clearly if our fuel supplies ever gave out, or if the price of gas ever rose to the point at which each trip in a car was felt to be an "expense," the economic shock to our system would be catastrophe.

Unlike our road squeeze, we have never had to face a gas squeeze—with the exception of the war years. On the contrary, in the face of a precipitously rising demand for gasoline, the price of the actual product itself has *declined*. In 1919 gas sold at the service station for 25½ cents a gallon. In 1959 it was 30½ cents—but 10 cents of the "higher" price represented *local*, state and federal gasoline taxes. During a period in which living costs had risen by two-thirds, the price of the fuel itself had actually fallen by one-sixth. Equally striking was the fact that direct taxes had risen to nearly 50 per cent of the price of the fuel itself, at a time when proposals for general sales taxes of two or three per cent were evoking strong public indignation.

Whether gas prices will remain economical in the face of the booming demand for gasoline in the future depends on many factors—the success of oil exploration, new developments in extraction and refining techniques, new economies of engine design, the competitive state of the market. But what is interesting to note is that, much as with the highway problem, the adequacy and price of our fuel supply largely hinge on sound tax policies. Incentives or penalties of taxation, inducements or discouragements toward exploration will—quite as much as the free play of market forces—determine the adequacy of the supply and the cheapness of the price of gas in the future.

Neither the proper means of financing our needed highway system nor the best methods for encouraging the maximum flow of oil are easy matters to decide. Without a doubt these will remain matters of legitimate debate for many years. But what may help to sharpen and clarify this debate is to bring into the foreground the main problem at issue. This is our economy on wheels itself. Neither highway building nor oil production are any longer—if ever they were—parochial questions which concern only those whose interests are immediately at stake. Behind the continuing debate looms an ever more pressing reality. This is to keep the wheels of our automotive economy rolling.

UNDERGROUND SHARPSHOOTERS

by Richard Sneddon

As a marksman, the driller of an oil well is in a class by himself. Unlike other sharpshooters, he is aiming at an underground target, and today he can control the course of his bullet—or drill bit—every inch of the way.

Translation of the crooked hole from an accident to an art was one of the greatest technological advances in the history of oil recovery. It opened to development hitherto irrevocable petroleum deposits. Simultaneously, it led to exciting new vistas of inquiry and research that have literally revolutionized the drilling industry.

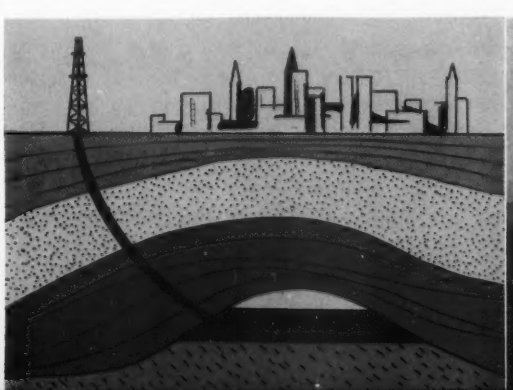
Today's "directional" wells circumvent a variety of natural and man-made obstacles that either rule out or frustrate straight hole drilling. They provide a means of extracting oil from formations deep under public and private buildings. They enable oil sands beneath turbulent waters to be pierced from onshore rigs. Directional drilling permits several wells to be drilled from a single offshore platform. The technique makes it possible to bypass unfavorable terrain features in locating a drilling rig, and to sidestep underground geological impediments.

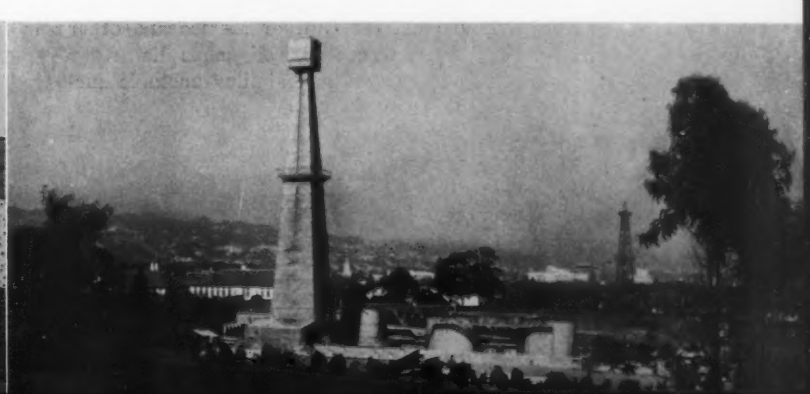
There are those who contend that deliberate directional drilling was suggested by the subterranean wanderings of the common gopher, but the oil people—who ought to know—maintain that it sprang from the efforts of a pioneer operator to bypass a fish, rather than abandon his well. (In oilfield jargon, anything that is lost in the hole is a fish, presumably because it has to be fished out, if possible).

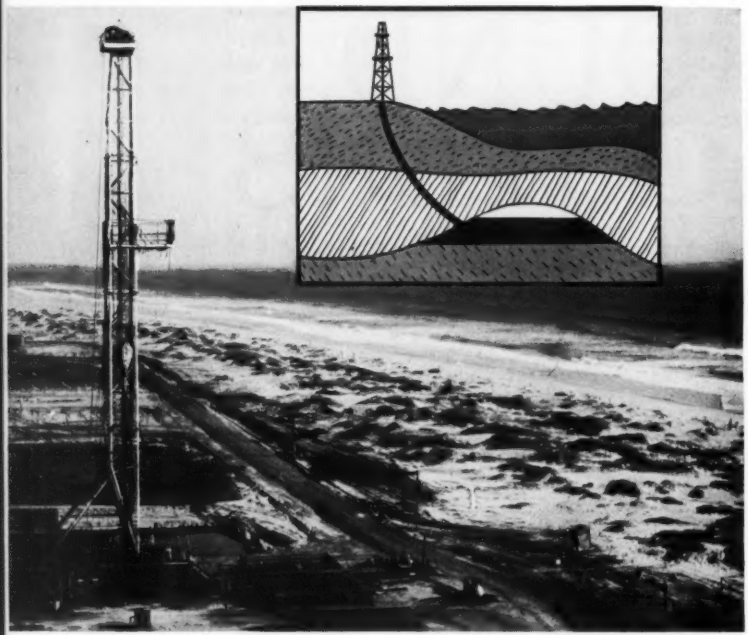
This fellow lost some sort of drilling tool in the hole and couldn't recover it, so he sent down a roughly tapered wooden log, thin end up, until it was resting on top of the fish. Then he slid the bit along the slanting face of the log and started it toward the pay sand by a slightly more roundabout route.

The modern "whipstock," so called because of its resemblance to the stock of an old-fashioned buggy whip, is just a variation of that first crude wooden defector. The new version is made of steel and is available in a wide range of accurately defined tapers. When it is correctly positioned in the hole, or "oriented" as the oil folk say, the bit is angled off its former path by the taper, and when the new bore is started the whipstock is withdrawn. A knuckle joint, another type of deflector often used, is merely a hinged tool that also faces the bit in a new direction. The deflecting procedure was originally repeated just often enough to work around the fish and bring the well back into per-

Soundproofed derrick marks site of directional well that taps oil pool beneath Hollywood movie lot.







Drillers in California can "bend" a hole under the beach without disturbing swimmers and reach oil deposits beneath the ocean floor a mile or more out.

pendicular alignment, but today it has no such limitation.

By constant application, the tools and techniques of the art have been improved tremendously. With the development of continuous well survey techniques and self-orienting deflection tools, controlled directional drilling has become a common practice. Today, there are wells that deviate as much as 60-75 degrees from the perpendicular and an expert driller with modern equipment can almost write his name in tubular script in the subterranean deeps.

A straight line is still the shortest distance from the derrick floor to an underground petroleum reservoir, and a great majority of oil wells are drilled that way. But in California at the present time, over 20 per cent of all wells drilled are of the directional type. The proportion is high also in Louisiana, the Gulf of Mexico and other producing areas where the oil sands lie under swamps, oceans, rivers and similar unstable surface elements.

In an early California enterprise, directional drilling made possible the tapping of a rich reservoir underlying a cemetery. It enables resourceful operators to recover oil from beneath residential and business areas in Long Beach and other cities, without disturbing the residents other than to send them scampering to the bank at regular intervals with their royalty checks.

A doctor in suburban Los Angeles permitted an oil company to whipstock under his property and is now reputed to be making more money from the well than the sick.

Almost 600 directional wells have been drilled along the Huntington Beach shoreline. They snake out under the ocean, some to a distance of a mile, to penetrate oil zones at depths ranging to 6,000 feet. In the past two decades, they have produced more than 250 million barrels of oil.

On one small man-made island, a mile offshore from Seal Beach, 32 directional wells already have been successfully completed and 38 more are scheduled. Well sites in the Ventura Avenue field, one of California's biggest producers, are mere shelves, from each of which multiple bore holes reach out to a complex continuity of oil sands. The terrain there is rugged and the reduced number of drilling locations materially cuts the cost of road construction and other incidental but expensive operational items.

The bit can be directed with uncanny accuracy to oil deposits beneath salt domes and other geological formations that make drilling difficult.

Not infrequently, underground salt domes are mushroom shaped and the oil-bearing sands lie under the lip. To go straight through the salt to the producing zone would be preferable, but the salt reacts to the drilling fluid ingredients and creates undesirable effects. A well drilled to the side of the dome and bored at an angle to the oil deposit bypasses the troublesome salt.

Directional drilling also eliminates the possibility of the loss of costly drilling fluids in the loose and permeable salt layers. As well, it can sidestep not uncommon super-hard rock layers that lie above the salt dome.

If disaster strikes a well in the form of a fire or blowout, it can be countered by angling into the hole from a safe distance, and stilling the turbulence through an injection of water and/or mud. Directional drilling is further employed to obtain cores of subsurface strata to evaluate prospective oil properties.

Mother Nature, a zealous old soul who has done an excellent job of concealing her oil treasures, must be getting a mite discouraged by the successful raids of the deviating bit.

TRIFLERS BEWARE!

by Frank Marshall

Hardship and heartbreak are the lot of those who seek oil in the Australian wilderness. But, with the aid of U. S. know-how and capital, the stubborn search goes on. At stake is the conquest of a continent.—

THE gravestones of a man, aged 26, and his wife, aged 22, stand as mute warnings to northbound travelers on the Strezlecki Track.

"Entering the Great Basin. Triflers beware!" proclaims a signpost.

Beyond this point, where drought pounds at the frontier like a heavy surf, such warnings disappear. Ranches and trading posts grow fewer. Grass becomes more spotty. Patches of red earth begin to show. Water gets scarce.

Finally, the land yields nothing but stunted eucalyptus trees, sand dunes and a blanket of shining red rocks called gibbers.

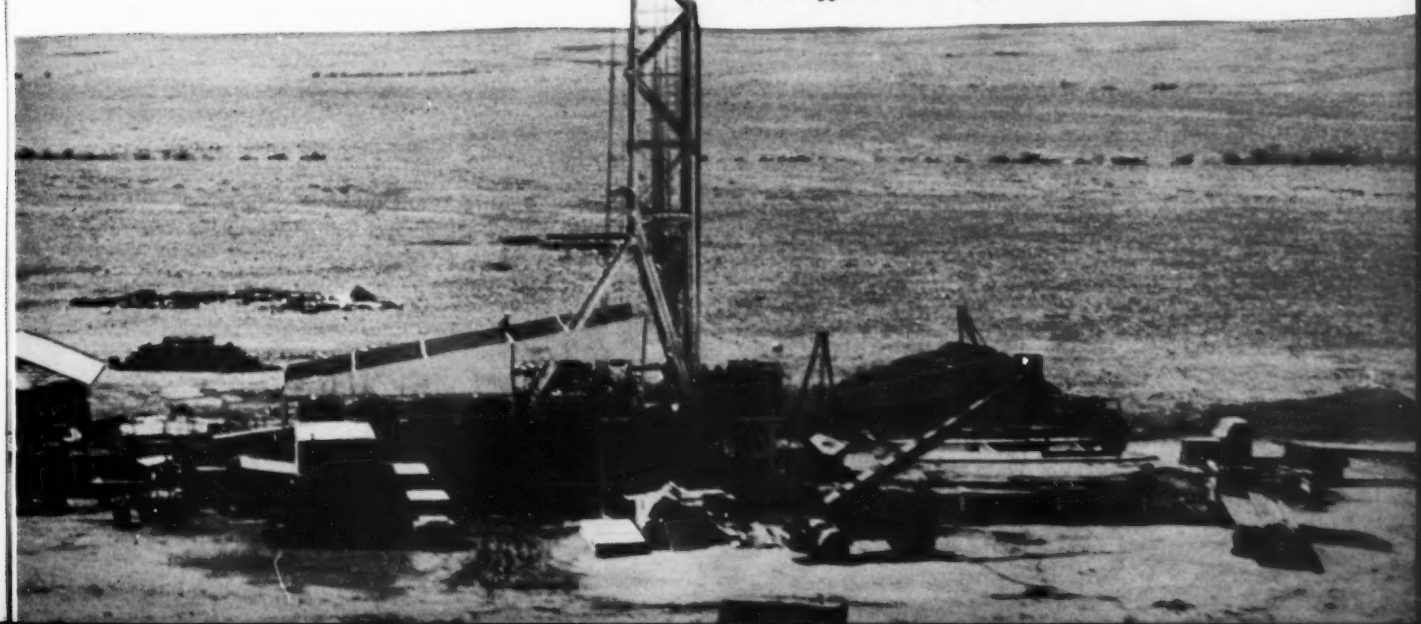
Here and there, kangaroos can be seen and, occasionally, an ostrich-like emu or a wild camel. Flies swarm from the desert, eager to explore the insides of men's mouths and ears. They don't bite, just crawl around. The temperature is 130 degrees in the sun. There is no shade.

In the middle of this wilderness, on a summer day last year, the Premier of South Australia sat on an applebox watching the crew of a giant drilling rig run sections of pipe into the ground. Premier Sir Thomas Playford had made a three-day, 700-mile journey by jeep, camping out at night, to reach the well named Innamincka #1 in Australia's Great Artesian Basin.

The Premier's pilgrimage and quiet applebox vigil reflected more than just the curiosity of a government dignitary. His was a patience and hope born of repeated failures in Australia's long struggle to uncover oil and gas deposits, the only basic resources she hasn't yet found.

Ever since the days of men who wore cabbage-tree hats and moleskin trousers, oil and gas have been reported floating or bubbling in water wells at various places on the continent. But the underground deposits forecast by these hopeful signs never materialized.

Innamincka #1 was the first deep "wildcat"



Innamincka Well #1—A lonely monument to those who struggle to find oil "Down Under."

The Hon. William H. Spooner
Minister for National Development

No single event could make a greater contribution to Australia's security, prosperity and general development over the next few years than the discovery of oil and gas in commercial quantities.

For 1959, our total imports of crude oil and refined products amounted to 90,000,000 barrels which cost a total of $297,000,000 including $72,700,00 for freight.

The importance of petroleum in the Australian economy is shown by the fact that it is the biggest single item in our import bill, representing 12 per cent of the total value of our imports. Australia is a developing country and our industrialization must increase with the growth of population and with it the demand for petroleum and its products.

The Australian Government, as is now well-known abroad, has been giving encouragement to the search by way of cash subsidy for approved stratigraphic drilling and geophysical surveys as well as making available liberal taxation concessions.

The American companies financially interested in the Australian search include the major oil concerns as well as a number of independents. These interests are making a valuable contribution in capital, manpower and equipment which my government welcomes and applauds.

well drilled in the 678,000 square miles of the Great Basin. It represented, for the hardy, barrel-built Premier and the Australian people, the newest hope in a long chain of disappointments.

"Wildcats" are exploratory wells in unproven territory. In the United States, about 80 per cent of such ventures wind up as "dusters" or dry holes. One out of 43 finds a deposit big enough to test out as a commercial success.

In Australia the record is even grimmer. Some 500 wells have been drilled over a period of 60 years, at a cost of over $150 million. None was successful. A few like the famous Rough Range #1 have behaved like spoiled prodigies: full of promise, but yielding only disappointment.

"They drilled Rough Range #1 in 1953," says Henry Kerr of Delhi-Taylor Oil, operator of Innamincka. "Gave it a good name too . . . hundred miles from the Indian Ocean on the west coast, 600 miles from the nearest railroad. Wild country.

"The well was a 400-barrel-a-day producer. 'Course by itself that ain't enough to fill a Stetson hat. But everybody figgered a good-sized field was there. Just needed developing . . . more wells. Everybody got real excited."

But "excited" is not the word. News of the discovery crossed the continent like a missile. West Australian Petroleum Company (WAPET), largely owned and financed by American oil companies, had found oil on its first try! Oil search securities soared on the stock exchange. The government, the people, the business community, all were elated. Planes were chartered to take officials to the scene and, as world attention began to focus on Rough Range, Australia seemed at long last on the verge of a new domestic source of power.

Shortly thereafter, a series of development wells was drilled around the Rough Range discovery. All were "dusters." The bubble burst.

In the next seven years, WAPET poured millions of dollars into 60 consecutive dry holes in Western Australia. And they're still drilling.

The excitement and hope generated by such "shows" of oil and gas in Australia are indicative of the country's need for a low-cost and easy-to-handle supply of energy.

At present, every ounce of oil Australia consumes must be imported via long tanker routes from the Middle East and East Indies islands. Oil is the continent's largest import and nearly 25 per cent of its total cost is for shipping.

World War II Japanese air attacks that destroyed oil storage tanks, grounding ready-to-fly warplanes, are not easily forgotten by Australians. Nor has the memory dimmed of enemy submarines probing the perimeter of destroyer screens in the Pacific for an opening to the Australian-bound tankers within.

Equally compelling is the fact that the lack of their own petroleum supply is hindering Australians in efforts to conquer their own continent. True, in the postwar years, population has increased about 2.2 per cent annually, gross national product has more than doubled and industrial production has tripled to $10 billion. Yet, in an area nearly as large as the U.S., the vast majority of Australia's 10 million people are still clustered along the southeastern coastline. Nearly half are concentrated in four cities: Sydney, Melbourne, Brisbane and Adelaide.

Australia, in other words, can be likened to the United States in the 1850's. The largest part, by far, remains untamed and in need of development. The soil in many parts of the country is unbelievably rich, but without water for irrigation.

"You can pour a pail of water on the desert," says American oilman Clifford Smith, "and when you come back a few days later, things will be growing on that spot.

"In Adelaide markets I saw shoots of celery . . . tender celery . . . this long." His hands extend a yard apart. "And cabbages bigger than basketballs. Carrots too . . . immense. People hardly believe me when I tell them."

Moreover, the continent has huge mineral resources in desolate areas, including what is believed to be the world's largest deposits of bauxite for aluminum. But without low-cost fuels, these cannot be developed to best advantage.

Coal, still Australia's principal source of energy, cannot be carried to places lacking rail connections. Nor can it run tractors, irrigation pumps and mobile machinery.

All-out encouragement to the search for oil and gas deposits by both the federal and state governments attests the overriding importance Australia attaches to petroleum. And, the country has been turning increasingly to America for the capital and technical "know-how" needed to further the quest for its own petroleum supply. (See statements on pages 8 and 11).

"They're really goin' all out" an American independent operator comments. "You can ask the government for action and 20 minutes later, it seems, you've got an answer. They're no forms in septuplicate, no sitting in waiting rooms, a minimum of red tape. It's quite a shock . . . like nothing I ever saw before in government.

"Believe me, without the help they've been giving, there'd be a lot fewer companies exploring there right now."

The incredible Innamincka #1 shows why.

The genesis of Innamincka can be traced back to 1953 and a balding, hawk-nosed Australian geologist named Reginald Sprigg. The story is told that while on an expedition seeking uranium, geologist Sprigg was flying high over the Great Artesian Basin, long considered non-oil country. A freak rainstorm had just ended and the carpet of dust that usually hovers over the ground had settled.

Far below, a series of domed structures of a type that often contains oil was clearly outlined, as far as the eye could see. Gently arched and folded on the land surface, they were so large that a man flying 5,000 feet high couldn't see their borders and so, would never know they were there. Reginald Sprigg, flying higher, saw them and became an oilman . . . almost.

By 1956, the company he had been instrumental in forming, SANTOS (Southern Australia Northern Territory Oil Search), had drilled 20 shallow wells for information, near the Great Basin. The face of the land there had been worn down. What oil may once have been trapped in the earth had escaped. But very small quantities were still found in almost every well.

Hope turned to conviction after Dr. A. I. Levorsen, a prominent oil geologist from America, advised that the Great Basin was strikingly similar, geologically, to the Sahara. Oil in quantity *had* to be near at hand.

At the same time, men with the same conviction were probing other parts of the continent. Sprigg himself once went north to the tropical belt around the Gulf of Carpenteria, known for its man-eating sharks and 20-foot tides.

He tells of the time he went for a swim, after first taking care to ask his aboriginal guides whether any sharks were in the area. When they replied "No," he stripped and dove in. Soon noticing that the guides remained on the blazing shore, he called to them to come in, but they refused.

"You said there were no sharks here," he called. "What're you afraid of?"

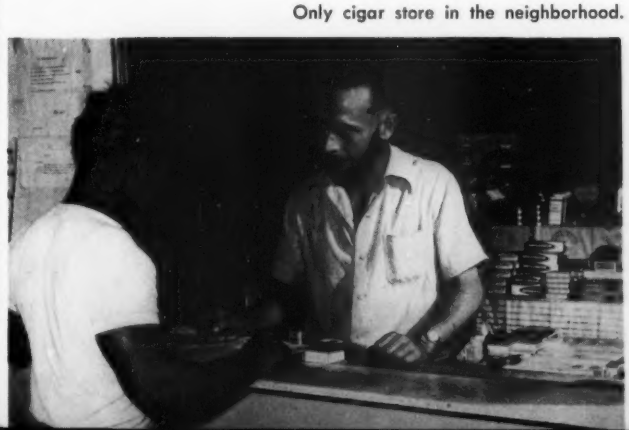
"The long noses," the guides hollered back. "Crocodiles."

Here, 20 to 30-foot crocs range up to 200 miles inland. The natives never take the same trail to water twice in succession.

"The ugly reptiles are so smart they only ambush the last person in a column," says Ike Newton, another American. "That's why native chiefs walk with wives both in front and in back." He then launches into a quieting description of royal-blue skies and green clouds of parakeets.

Although the obstacles are many, this area too will probably see oil rigs rising in the future.

Only cigar store in the neighborhood.



Swimming pool at the Innamincka-Hilton.

The hunt is too crucial to be turned back.

In 1958, SANTOS, with 170 million acres leased in the Great Basin, turned toward the United States for help. Within months, an agreement was reached with Delhi-Taylor Oil of Dallas, Texas, and with the Frome-Broken Hill Proprietary, a group of American and British oil and metal companies with interests in Australia, to finance and operate a drilling program in the Great Basin.

The pattern was a familiar one. In Canada, Ike Newton points out, nearly 3,000 wells were drilled before oil was found. Much of the backing came from American companies. "They spent millions in the Sahara, too, and it took years. Same thing with Cuba . . . but not much luck so far. Now we're trying Australia."

So in late 1958, the forces behind Innamincka got moving. Henry Kerr and Norman Miller of Delhi were among the first Americans to arrive. They put together a continent-wide jigsaw puzzle that eventually shaped up into one working unit.

"The first problem was to get a rig," says Kerr with an easy drawl. "We found one . . . the only one on the continent that could do the job . . . way out on the west coast. Then we had to get it out of there. Ended up sendin' part by truck and part by ship to Perth. Then we sailed the whole works around through the Indian Ocean to Adelaide."

Next problem was supply: construction equipment, a billiard table, sheet metal, insecticides, a movie projector, diesel engines, beer rations, medical supplies, an airplane, razor blades, drill pipe, refrigerators. An endless list.

"There were only nine trucks on the continent that could handle rigging equipment . . . and by the time we got through, we had enough gear for almost 70 truck-loads. Had a little trouble," Kerr understates, "but we finally got together about 50 trucks . . . and we were ready to go."

The destination of the truck caravan that left Adelaide in January of 1959 was Innamincka, a ghost town well-known to many Australians. A popular quiz show has long offered its winners free trips to a number of places, Innamincka included. The town derives its fame from the fact no winner has ever chosen to go there. "And, I don't blame them," an American oilman readily adds.

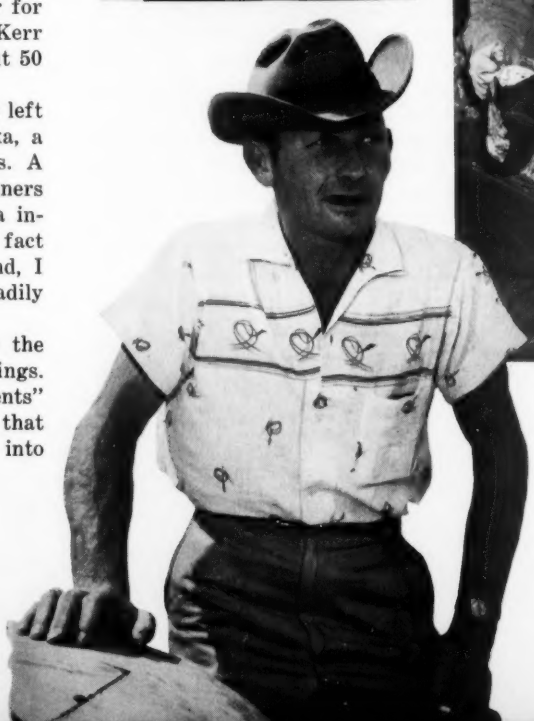
Innamincka, however, has more to offer the curiosity seeker than a few dilapidated buildings. Indeed, it has one of the strangest "monuments" in the world—an awesome heap of beer bottles that over the years have been melted by the sun into one solid glass pyramid.

Spearheaded by government road-graders that broke a path, the caravan took three weeks to crawl the 700 miles to this spot. Not all made it. Some trucks were left among the dunes. Eventually, however, most of the equipment got through.

An advance party had already cleared an airstrip and solved one major problem—water.

"We spent $75,000 to find water," says Norman Miller. "Took us weeks. Found it finally 11 miles away . . . had to lay pipelines to bring it in. Time was when you could drill a whole 'wildcat' for that much money. But no more. Not by a long shot."

Finally, in March, drilling of Innamincka #1 got underway. Four crews—made up largely of men brought in from the oil fields of Texas 9,000



Men of many nations work on the oil frontier of Australia.

miles away—worked round-the-clock in shifts or "towers," as they're called, for eight long months. It was not easy drilling.

"We were a long way from home and help," says 'Tiny' Guynn, who was drilling superintendent. "Had to get used to each other, the heat, the flies, the empty country. Had to run a good safe operation too. If anybody had gotten hurt bad . . . 350 miles from the nearest town . . . he could've died out there before help came. But we were lucky . . . no bad accidents."

To relieve the monotony of isolation, one crew was flown back to Adelaide every 28 days for four days of rest and relaxation. At the camp-site itself, the 50-man battalion passed time at the "pub" which opened after each "tower" had ended. Beer ration: two bottles a day. Movies were shown three times a week. Poker was continuous.

"That's how I learned to count Australian money," laughs "Frosty" Maxwell. "Just one night o' poker and all them shillins' and things seem to explain themselves."

Slowly the well progressed. At 4,782 feet there was a show of fluorescence, a good sign of oil. Then nothing further. Again at about 6,800 feet a trace of oil was found.

Sample cores were taken from the well, analyzed in the field, and sent back to Dallas for more study. New crew members, flown in from the States, replaced older ones. A radio-cable system relayed spot information to Texas. The well was being supervised from another hemisphere.

While all this was happening, a host of other American companies, large and small, was entering the Great Basin for geological and seismic surveys on new leases. Attracted by findings at Innamincka and encouraged by the government, activity in the area was picking up at a rapid rate.

All over the continent, in fact, companies were at work. Maryborough, Gippsland, Eucla, Bonaparte, Bowen, Canning, all of these areas were being probed. They still are.

Recently, a well at Port Campbell had encouraging "gas shows." Several wells around Sydney also have found small amounts of gas. A new discovery had been reported in Papua, Australian New Guinea. And a well is now being drilled near Roma where, 50 years ago, natural gas blew into a water well and burned for days. The sum total of these ventures: a lesson that energy just doesn't appear. It must be hunted.

The hunt at Innamincka wore on into November of 1959. At one point, drilling was suspended for three weeks while the crew went "fishing" for a bit that had broken off at the bottom of the hole. When it was recovered, work resumed. In subsequent weeks, several oil traces were found.

Then, on the eve of December 1959, at a depth of 12,650 feet, a final verdict was reached:

"Abandon and move out. It's a duster."

The total cost: over $1.5 million.

Clifford Smith shrugs his shoulders, but not without concern. "That's the business we're in," he says. "Stateside odds aren't much better. But we learned a lot from Innamincka."

"We completed it as a water well, by the way. Damned expensive water. Now we're drilling at Betoota in Queensland in 145 degree heat. Spent another fortune finding water there too . . ."

Thus, this strange saga goes on, even in the face of $150 million worth of disappointment.

Why keep going?

The answer of one American leaseholder is typical: "The company that hits will profit right along with the continent and its people. It's a long shot, granted, and somebody's going to go broke. But, that's true anywhere. Oil's never easy to find."

Those who believe otherwise might well give second thought to the warnings along the burning Strezlecki Track.

"Triflers Beware!"

The Hon. Frank Nicklin

Premier of Queensland

In a comparatively youthful civilization like Australia, and particularly that part of it called the State of Queensland, the location of commercial quantities of petroleum would have an economic impact infinitely greater than the discovery of gold brought in its infant days.

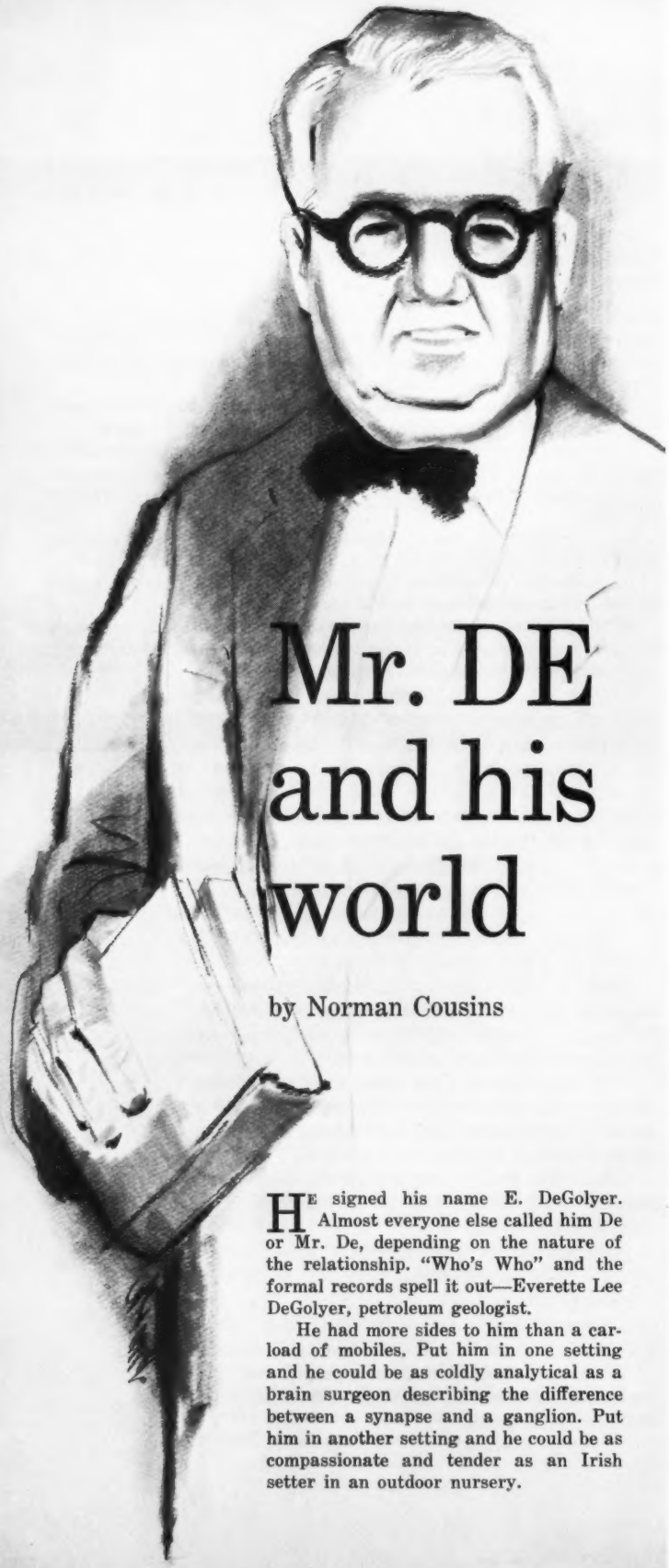
Oil exploration in Queensland, and in its southwestern component, South Australia, has maintained an increasing tempo in the past two years.

At present the whole of Queensland is held under oil prospecting title and about half of that titled aggregation is held by overseas interests. Another one-third has been taken up jointly by Australian and overseas interests.

These groups have poured large sums into the search and continue to do so, confident in the belief, which I share, that oil will be found.

The promotion of exploratory work has been brought closer to fruition by the infusion of American capital and technical know-how.

On behalf of the Government and people of this State I wish them early success in their efforts and a reward commensurate with the funds they have expended in their quest.



Mr. DE and his world

by Norman Cousins

He signed his name E. DeGolyer. Almost everyone else called him De or Mr. De, depending on the nature of the relationship. "Who's Who" and the formal records spell it out—Everette Lee DeGolyer, petroleum geologist.

He had more sides to him than a carload of mobiles. Put him in one setting and he could be as coldly analytical as a brain surgeon describing the difference between a synapse and a ganglion. Put him in another setting and he could be as compassionate and tender as an Irish setter in an outdoor nursery.

And he could slide from one role to the other without any perceptible grinding of emotional gears. At an informal dinner one night in New York he was the complete scientist-historian, explaining mining techniques in ancient Greece. You had to listen carefully, for he didn't waste words and he spoke with deceptive ease. What impressed you was the total lack of the extraneous or the emotional in his command of the subject. You had the feeling that every word had behind it total research. Here, you thought, was the ideal marriage of history to science.

From dinner we went directly to the theatre. If my memory is correct, we went to see "Allegro" by Rodgers and Hammerstein. Within five minutes after the curtain went up, De was emotionally involved in the story as though he had lived it. His tear ducts shifted into high and stayed there. During the intermission he dried out. He met a geologist friend who asked a question about the oil reserves of the Persian Gulf area. Once again, De was the precise, dispassionate scientist, putting one fact down after another in proper weight and progression. When the play resumed, De surrendered promptly and completely to the sentiment of the story. He was the playwright's delight.

No man had more respect for the scientific method; yet few have gotten more mileage out of their hunches —even when all the evidence seemed to go the other way. His mind was like a spark jumping across gaps. Once, a subordinate reported that he had dug five dry holes in a field, having gone down to 12,000 feet. De told him to stay put and go down another 2,000 feet. The rest was almost inevitable. They hit at 14,000.

When I asked De what caused him to give the order to drill the additional footage, he bit hard on the end of his twisted Mexican cigar, grinned and said: "Damned if I know. I'm just lucky."

De *was* lucky; but it wasn't blind, stumbling luck. He knew every wrinkle in the face of Lady Luck as though he had drawn the original sketches. He could translate her slightest whisper into a marching order. He knew where she lived, where she kept her charms, where she went for her winter vacation. Most of all, he knew when not to press her too far. If De was lucky, it was no accident. He had bound the lady to him with hoops of steel.

De didn't try to monopolize the girl. Indeed, he expected the people he hired to be lucky, too. Once he interviewed a young petroleum geologist for a job in his firm. Mr. De listened patiently while the applicant told of his scholastic honors—third highest in the state, winner of the Alumni Award, bearer of a special commendation from the president of the university.

"This is very impressive, son," Mr. De said. "Now, just how lucky are you?"

The youngster thought Mr. De was joking and stammered an unintelligible reply.

De gave the young man a short lecture on the importance of being not only smart but lucky, then hired him. The youngster turned out to know the kind of luck De expected. De didn't hesitate to give him important assignments.

I discussed this case with De.

"Suppose that youngster happened not to be lucky

in your terms?" I asked. "Suppose he did everything according to the latest scientific knowledge—but just didn't happen to hit. Then what?"

"I probably would have had to fire him," De said reflectively. "A fellow out looking for oil who doesn't know how to be lucky is in the wrong business."

"But surely you can't tax a man for not being lucky?"

"The hell I can't," he shot back.

I sat silently and uneasily with that reply for a moment. De watched me carefully, then smiled.

"Look," he said, "luck isn't just a matter of having a pot in your hand when it rains Kentucky Bourbon. Maybe it's a matter of knowing what to do when you get dead-ended by the printed guides and instructions. Organized and systematized knowledge can carry you only so far in a field where the answers thin out very fast. You've got to be able to generate a sort of momentum of the senses to carry you into zones where the book doesn't operate. If you say this is a pretty high-falutin way of describing a hunch, I'll agree with you."

I asked Mr. De to tell me about his Potrero del Llano No. 4 strike for Mexican Eagle Oil—one of the most productive single wells drilled in the Western Hemisphere. He was a college kid at the time. Would he say that his fantastic discovery of Big ME was the result of a hunch?

He grinned.

"I was pretty raw then," he said. "Even so, I had spent a fair number of hours thinking about this crazy business. I had been out in the field during the summer with Willard Hayes of the U. S. Geological Survey. I'd read the books carefully and listened around to some fellows who seemed to know a thing or two that wasn't in the books. I began to think of ways of finding oil that weren't confined to the conventional methods. One of them worked. I was lucky."

"In that case," I said, "you were lucky in the sense that your original theories worked. But you had to have the theories even before you could test your luck. You just didn't happen to point a finger at a spot in the earth and say, 'Let's try this on for size.'"

"I'm not going to argue with you," Mr. De said. "I'll just rest my case on a single observation. You can take it as a law of success that when a fellow happens to hit it big, the more honest he is about saying how lucky he was, the more disposed people are to credit him with being a wizard. Anyone worth a damn doesn't have time to think of himself as successful; he's too busy mulling over all his mistakes and muffed opportunities."

Mr. De never concealed his poor-boy background. He was born in a sod hut near Greensburg, Kansas, on October 9, 1886. His father was John William DeGolyer, a prospector and homesteader. His mother was the former Narcissa Kagy Huddle.

When Mr. De looked back on his youth, he said he was struck with the fact that, as he grew up, he regarded the economic hardship of his family as of no special consequence. He had no particular resolve to become rich—as a reaction to the extremely modest circumstances of his upbringing. He accepted as a matter of course the need to work his way through the University of Oklahoma. Most of his friends had had to do the same. In fact, if it hadn't been for the need to work his way through school, he would never have met C. Willard Hayes of the U. S. Geological Survey, whom he credits with having led him up to the turning point in his life.

During summers, he worked under Hayes in field surveys. He was short-order cook and long-order beer dispenser. Whatever his proficiency in the kitchen, young De was even more adept in the field. And when Hayes became associated with Lord Cowdray of Mexican Eagle Oil, Ltd., he brought De along with him. Here came the vital turning. Lord Cowdray spotted DeGolyer as a winner and gave him plenty of scope. De was still a college boy but he had learned his field work well; he had also done a fair job with the textbooks in geology under Charles N. Gould. What attracted Lord Cowdray particularly were certain qualities in De that were to make him eventually the world's foremost figure in the geophysical exploration of petroleum. He was unorthodox but methodical, severely analytical but highly imaginative, skeptical but intellectually curious, a thorough disciple of scientific inquiry and the scientific method but an inspired respecter of hunches.

After young De brought in Potrero No. 4 in Mexico, Lord Cowdray tried to persuade him to come to work for Mexican Eagle the year 'round. But De decided to go back to college. As Cleveland Amory quipped, De was a millionaire before he was graduated from the school he was working his way through.

It would take a book to do justice to Mr. De's subsequent professional career and achievements. Among the highlights were his part in the founding of Amerada Petroleum Corporation; his pioneering work with torsion balances and the refraction and reflection seismographs; his leadership in the Geophysical Research Corporation, with its history-making record in Texas and Louisiana; the spectacular discoveries for Amerada in the Seminole Plateau in 1930; his work as Assistant Deputy Petroleum Administrator in World War II; his revolutionary predictions about the oil reserves of the Persian Gulf area; his various scientific medals and honors; his Presidency of the American Institute of Mining and Metallurgical Engineers, and his directorships of the American Petroleum Institute and Southern Pacific Railroad.

Not so well known, however, was the nature of the man himself. Indeed, he was something of a legend in the petroleum industry, regarded as a combination of maverick and mystery man. This was largely due to the great deal of time he spent in pursuit of his many outside interests. He would, for example, go running off for days at a time just to track down a book by some Spanish fellow named Cabeza de Vaca.

There was nothing feigned about this side of Mr. De. He had an abiding delight in book collecting and the creative life. His own writing was a painful joy, however; he would spend hours on a sentence just to make sure it turned right. He filled out thousands of catalogue cards by hand in preparing his notes for

what was to be the major literary effort in his life—a history of the petroleum industry—a project his illness prevented him from completing. He was an indefatigable researcher. He would hunt down even the smallest fact with a relentless tenacity generally associated with TV dramatizations of Scotland Yard.

His private library, like the man himself, was wide-ranging, well-organized, primed for constant action. It is doubtful if anyone built up finer private collections in the fields of Southwest Americana and folklore, the early exploration of America, the history of science, Charles Darwin, or Morleyana (he owned everything Christopher Morley ever wrote, some of them in original manuscript). The collection on the history of science, running into thousands of volumes, he presented to the University of Oklahoma without condition or stipulation. "No point in giving them money or a building," he said, "They've got plenty. But did you ever know of a university that didn't need good books?"

He placed a value above pearls on good talk. He himself had a remarkable conversational change of pace; he could mix up abstract ideas, earthly illustrations, scientific data, random speculation, and droll stories. Once, after he had spent almost a week on the campuses of Harvard and M. I. T. at some geophysical meetings, I asked him if his trip had been productive. "Couldn't have been a better trip," he said, "I picked up two good stories."

He knew people all over the world—government officials, industrial leaders, fellow oilmen, scientists, writers, editors, newsmen, printers, booksellers, college presidents and professors, cab drivers, head waiters. But he picked his intimate friends carefully.

I met Mr. DeGolyer for the first time in Dallas in 1941. John William Rogers, the author and playwright, got permission from Mrs. DeGolyer to show me Mr. De's famous book collections. Mr. De was there and took me on a personal tour. He showed me original manuscripts of articles that had been published in my own magazine, then opened the door to a small storage closet and showed me a complete file of the Saturday Review since it was founded by Henry Seidel Canby, Amy Loveman, William Rose Benet and Christopher Morley in 1924.

Mr. De asked me to stay to dinner. The next day I asked him if he would like to own the magazine. We really needed help in those days: we were two months behind in our printer's bills.

Mr. De held out his hand: I took it, and that was that.

"Just one condition," he said. "If you spend one damn cent for lawyer's fees in drawing up any papers to formalize the deal, it's off. We've already shaken hands; that's enough."

For 15 years De was the owner of the Saturday Review and my boss. Not once in all that time did he suggest or intimate that the editorial page or the magazine take any turn to coincide with his own views. He gave me, quite literally, all the freedom in the world. My main problem was not to fight for editorial independence but to justify the independence I had.

One day, I received a telephone call at SR from an officer of a patriotic organization in Dallas. He said he had just learned that I was scheduled to speak in Dallas on the subject of peace, under the auspices of Quakers. He suggested I withdraw from the meeting, for his group intended to picket it. The meeting seemed to him to be questionable in terms of possible subversive associations. He pointed out politely that everyone connected with the meeting would be in the line of fire. Since Mr. DeGolyer owned the Saturday Review, my appearance might prove embarrassing to my boss in his home town.

I told the gentleman that I hoped he would look into the history and background of the Society of Friends, for it was quite possible that any embarrassment over the meeting might belong to those who accused the Quakers of subversion. In any event, if my appearance at the meeting would be embarrassing to Mr. DeGolyer, then Mr. De would have to tell it to me himself. I suggested the gentleman take the matter up with Mr. De.

He did so. The results were completely predictable. Mr. De told him to jump in the lake. He then telephoned the Quakers, asked if he could join the sponsors of the meeting, and volunteered to introduce me. He telegraphed a message saying he expected me to come to Dallas and to be sure to stay at the house.

The moment it was announced that Mr. De would appear on the program, all opposition collapsed. There was no picket line, just an overflow crowd, many of them attracted no doubt by the prestige of Mr. De's name. The entire episode was one that would have made Mr. Oliver W. Holmes sing for joy.

It was the only time Mr. De had introduced me at a meeting, or, for that matter, had heard me speak publicly. I can't remember a more generous introduction or one that touched me more deeply. On the way home, Mr. De congratulated me on the talk and added he didn't agree with a damned thing I had said. We laughed, then spent the rest of the evening talking about the new publishing program of the University of Oklahoma Press, the need for a new history of science, and the mess the Dodgers had made of the World Series.

Mr. De died in 1956, just before Christmas. It left a terrible hole in my life. He went by the political name of conservative; but he taught me a great deal about genuine liberalism and the largeness of the human spirit. He taught me, too, not to place stock in stereotypes—whether they went by the names of industrialists or intellectuals. The Saturday Review would not be possible without him. Some weeks before he died he told me he got a bigger kick out of the success of the magazine, after so many years at the bottom of the barrel, than out of his biggest oil strike. I knew he meant it. He never took a cent out of SR, and when there was no longer any question about its ability to go it alone, he transferred his ownership to the people who had the responsibility for publishing it.

I felt proud to have worked for him. I felt even prouder to have had him for a friend.

Oil Field Fables...

The 16-inch Bulldog

When any piece of equipment is lost in a well, it becomes a "fish." The task of recovering it is a fishing job and the devices used are fishing tools.

There are as many fishing tools as there are flies in a sportsman's tackle box, but they are of two general types.
Those that go inside a hollow object are called spears;
those that fit over the lost object are known as overshots.

A bulldog spear is a sliding wedge with sharp corrugations that cling to the inside of a piece of drill pipe or well casing like a bulldog. It cannot be released until brought to the surface. Rig crews refer to these fishing devices simply as "bulldogs."

In 1907, an American company sent to its Mexican properties an engineer whose previous experience had been in railroading. After a brief stint in the field, he was due to return to the U. S. for a visit before taking up a long residence in Mexico.

Before leaving for the States, he asked the field superintendent if there were any items of equipment not available in Mexico that he could either order or bring back with him. The superintendent replied that he might be doing some fishing and would like a 16-inch bulldog.

The next meeting of the two men took place in the lobby of the hotel where the engineer was staying on the day of his return to Mexico. After exchanging greetings and small talk for a few moments, the superintendent inquired: "Did you get me a bulldog?" "Yes," said the engineer, "it's up in my room. I'll get it for you right now."

He returned leading a brindle bulldog approximately 16 inches long.

Ellen Burger

Subsurface rock formations in which oil has been struck traditionally are given non-geological identifications. They may be named for the new oil field that was brought in by the strike, for the discovery well or for the wildcatter, geologist or someone else responsible for the find.

Folks in Coleman County, Texas, were accustomed to hearing oil scouts and geologists refer to the formations underlying their area as The Ranger, The Caddo, The Palo Pinto, The Morris, The Strawn and, deepest of all, The Ellenburger.

A farmer, who had leased his 300 acres for drilling operations, spent most of his waking hours watching the first well go down. As each formation failed to show a sign of oil, he pinned his hopes on the next. Finally, only the Ellenburger was left. As the well approached the depth where this formation would be encountered, if at all, he could hardly sleep.

Exhausted by many hours of anxiety, he left the well at 2:00 o'clock one morning and trudged to the house to try to get some sleep. He managed to drop off but it was a far from restful sleep and his tossing and talking kept his wife awake. She had to listen to such pleas as, "Come through Ellenburger, come through old girl. Don't let me down, Ellenburger."

At daybreak the bleary-eyed farmer went to the kitchen, where his wife had preceded him, and asked if she had any news from the well. But her mind was not on the well, and she had not started breakfast.

"I heard you talking in your sleep this morning," she replied tartly. "Who is this Ellen Burger? You better tell her to cook your breakfast."

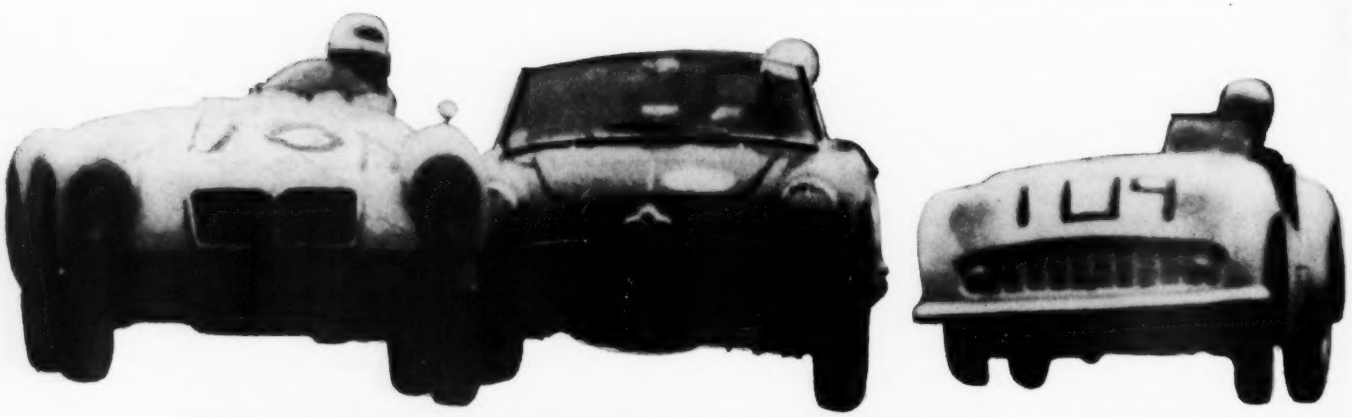
Mody C. Boatright

The sun had not long been up when clusters of cars and people began forming along the runways and taxiways of a small airport near Mansfield, La., on a recent Sunday morning.

Preparations were underway for an amateur sports car racing meet, a relatively new American pastime. Each contestant, with an entourage of family and friends, was at his station or "pit" along the makeshift course. Drivers and their "pit crews" were tuning up engines. Soon hundreds of spectators would join these enthusiasts for a seven-event race day program.

Among the helmeted drivers, garbed in fireproof racing suits, were a doctor, a salesman, a teacher, a lawyer, a garage operator, a pilot and an accountant.

The cars, themselves, were as varied as the drivers' occupations. Some were conventional sports cars which, minus roll bars and other safety devices required for racing, transported the family during the week. Others were special "souped up" sports



SOPHISTICATED HOTRO

cars. A few were trimmed-down vehicles built just for racing.

Races were run off according to rules laid down by the Sports Car Club of America, whose standards of safety and fair play are subscribed to by more than 1,000 local independent clubs in the country.

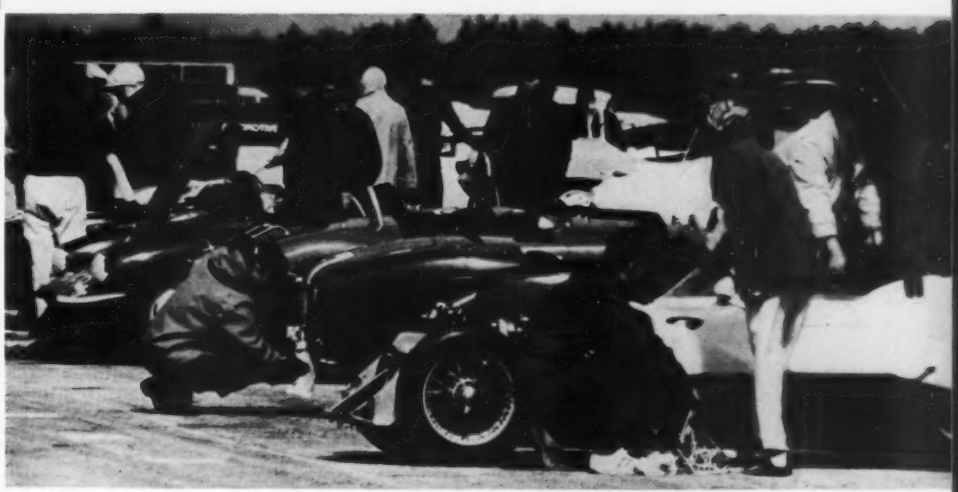
Drivers actually represent only a small segment of SCCA's membership—2,200 out of 12,000. But, the non-drivers are no less wrapped up in the new hobby. Some are active as members of a "pit crew" or as habitual rooters, but most are simply "kindred spirits," who are content just to be part of the fraternity.

The only tangible prize for the winner of an amateur sports car racing event is a trophy. But, the satisfactions are many. One is the thrill of speed (from 85 mph to 165 mph, depending on the class of the racing car) and of competition in driving skill. Another is pride in car performance together with the satisfaction that goes with having tooled up to racing perfection.

Race Day rooters cheer from the boondocks.

A contestant puzzles over engine trouble.

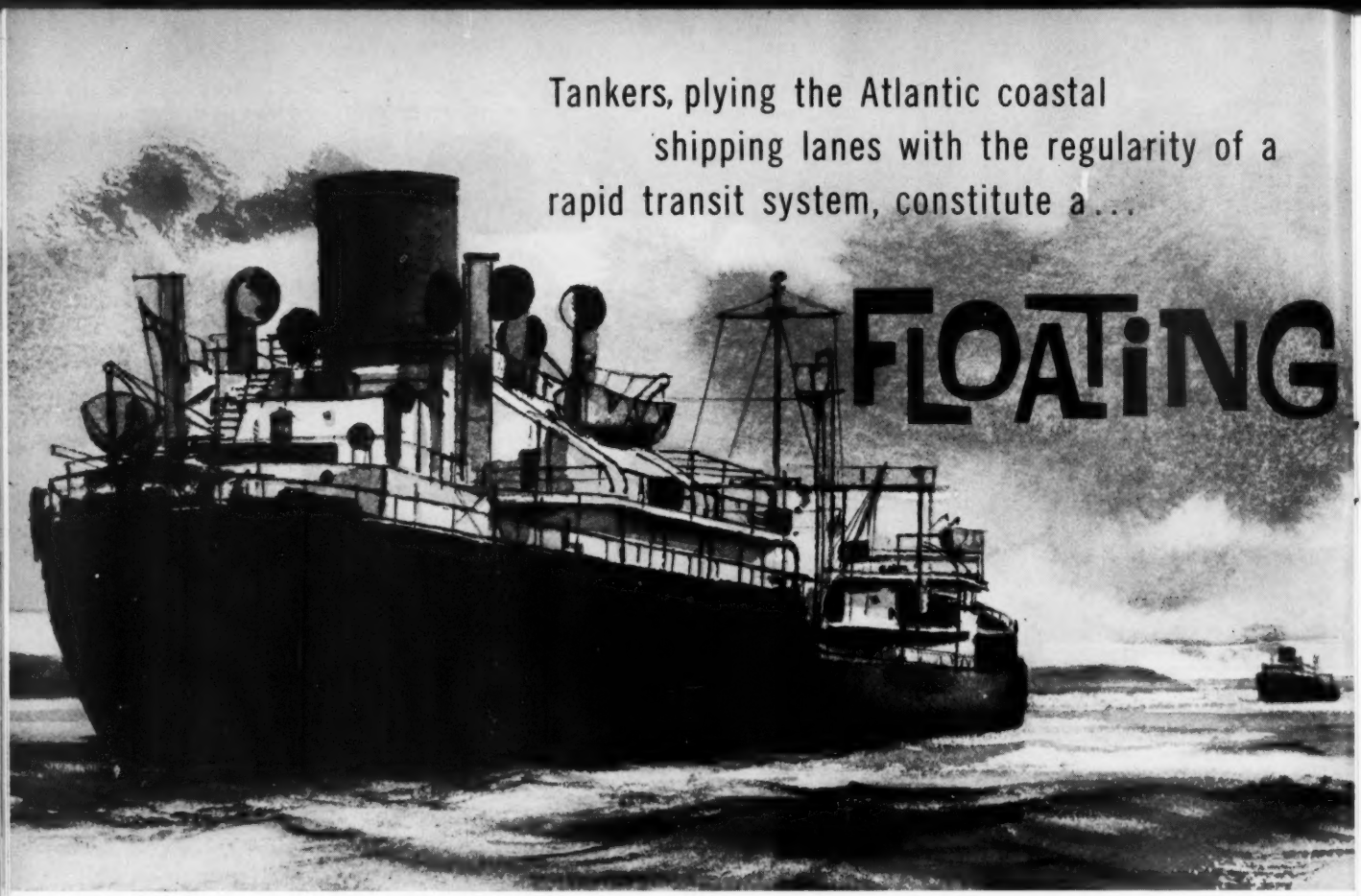
This is one man's sport where the women do more than tag along.



RODDING

The payoff—a trophy and wifely pride.

Junior joins Dad for the ride to the winner's circle.


Tankers, plying the Atlantic coastal shipping lanes with the regularity of a rapid transit system, constitute a...
FLOATING

WE sailed at noon from Marcus Hook.

The huge tanker was leaving one of America's largest refinery areas near Philadelphia, Pa., for Beaumont, Texas, to take on another cargo of crude oil.

I was aboard the *Western Sun,* a vessel longer than two football fields and a home away from home for 41 crewmen. She is one of 330 tankers that ply between the Gulf of Mexico and East Coast ports with the regularity of a rapid transit system. If the fleet were spaced out evenly along the 1,800-mile arc prescribed by the costal shipping lane, there would be a tanker in sight from both bow and stern of each vessel the whole way.

It was the savage attempt to disrupt this vital oil supply line that brought Hitler's U-boats close to U. S. shores during World War II. The submarine attacks forced a crash program of pipeline construction to provide an alternate channel for petroleum fuels needed by American fighting forces and home front arsenals.

Peace time has by no means lessened the economic significance of our coastal tanker fleet. For the nation's consumption of oil has increased from 4.5 million barrels daily in the early war years to about 10 million today. With tanker shipping costs under two cents a barrel per 100 miles, slightly less than pipeline and much less than surface transportation costs, the importance of this coastal sea lane in sustaining an economical supply of petroleum products goes without saying.

The deck of the *Western Sun* was bathed in sunshine as we left the mouth of the Delaware River that Friday afternoon and headed out to sea. We would go out just beyond the thrust of the Gulf Stream so that, as Captain Frederick Klein explained, we would not be slowed down by this river within an ocean. We were going 17 knots, average for modern tankers.

Despite the fact that she has double the cargo capacity of the mass-produced T-2 type tankers of World War II, the *Western Sun* has only five more in her crew. The efficiency of a tanker climbs sharply as size increases, but general operating expenses advance at a slower rate. I was told that a 50,000-ton tanker with a capacity of one-half

PIPELINE

by Frank Braynard

more than the *Western Sun*'s requires only four more crew members. Giant 106,000-ton tankers now under construction will carry three times her cargo, with 53-man crews.

Under present circumstances, however, a good percentage of the economies inherent in giant oil carriers is dissipated by costly transfers of cargo into smaller craft at unloading ports. Today's supertankers need far deeper channels than are available in all but a few ports of the world. New offshore loading via floating oil depots and connecting pipelines may be an answer to the problem.

I spent the first afternoon walking around the ship. Larger than most ocean liners, she has a designed 251,000-barrel capacity. This would be equal to 10,542,000 gallons, or enough gasoline to get 50,000 cars to San Francisco from New York City. Cargo is carried in 30 separate tanks, three rows of 10 each, in the hull.

Chief Engineer Harry Moorehead took me in tow the next morning for a tour of the great 50-foot-high engine room, which houses a 13,500-horsepower engine.

Passing the fire boxes under the boilers, I looked through a purple-tinted, plexiglas opening at a writhing pink-white mist of flame. The temperature inside was 2,600 degrees F.

In one corner of the room, there was a machine shop where "we can do anything," the chief said proudly. He introduced Machinist Clarence McCullough, whose skill in rolling his own cigarettes was second only to his mechanical ability.

On the bridge, I watched First Officer Frank Martilik write in the ship's log: "Occasional rain, confused sea." Ahead, a gray arch of clouds made a natural bridge in the sky. I walked far forward, breathing heavy gusts of fresh salt air.

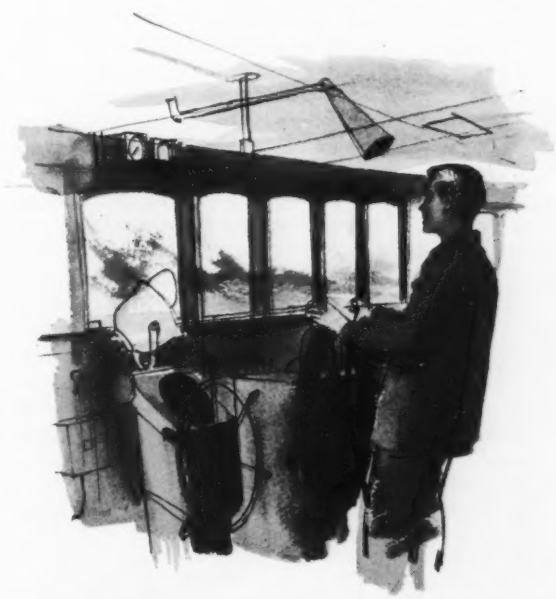
"I thought you were going to climb the mast," Captain Klein said with a smile when I returned to the wheel house. Like many of the ship's officers, he had come up through the "hawse pipe"; that is, he had worked his way up from an ordinary seaman. As we talked, the weather report was coming over the wireless. It gave gale warnings.

The storm was coming on gradually by lunch time. Steward Nicholas Di Nunzio served tenderloin steak, two if you could eat them. While we were at the table, Fred Cushman, the second officer, reviewed the ship's work routine. As on all ships, each 12 hours are divided into three four-hour watches.

The captain and chief engineer are always on call. The six officers in the deck and engine departments each have a watch. Except for three deck maintenance men, the radio operator and those in the steward's department, each crewman serves four hours on watch and eight hours off, around the clock. Messmen are around to put out trays of cold meat, cheeses, bread and butter for each of the three night watches.

That evening, I watched television. There was a set in the officers' lounge and another aft for the crew. They were the center of the ship's social life, although there were a variety of other recreational facilities—dart games, cards and two libraries. Two movies are shown during each voyage.

"They play basketball in the cargo hold on one of our sisterships," remarked messman Edward (Scrappy) Scarpato. Scrappy, a dead ringer for Mickey Rooney, has a sideline enterprise aboard ship. He runs the "slop chest," a canteen from which crewmen buy cigarettes, candy, shaving



cream, etc. "They call my cabin Fort Knox," he explained, "because it's always locked." Although he looks very young, Scrappy has been at sea eight years and has a wife and small daughter back home.

The storm gave me a rough night. We were rolling about 15 degrees each way. The sounds of falling objects together with the constant rattling of the venetian blinds in my cabin made sleep impossible for a landlubber. I finally gave up and at 4 a.m. made my way up to the wheel house.

It was an exciting place from which to watch the black horizon tilt up and down. The only illumination came from the little red and green lights on the instrument panel. I thought of the countless motorists who buy gasoline each day and the thousands of homeowners who use heating oil brought up by tankers. Did any of them have the slightest idea of what went on aboard the great fleet of ships moving constantly along the coast to supply their needs?

Helmsman Charles Knight chewed tobacco as he grappled with the wheel. The automatic steering device (Metal Mike) couldn't take such weather. Off duty, Knight's time was spent making radios. He'd made one for each of his five grandchildren. He was also known as the ship's astronomer because of his extensive knowledge of the stars.

As my eyes became accustomed to the darkness, I made out the captain's bathrobed form. He had stayed on the bridge through the night and soon would order his breakfast, an egg sandwich, brought to him. The silence was emphasized by the sound of a pencil rolling back and forth on the chart table.

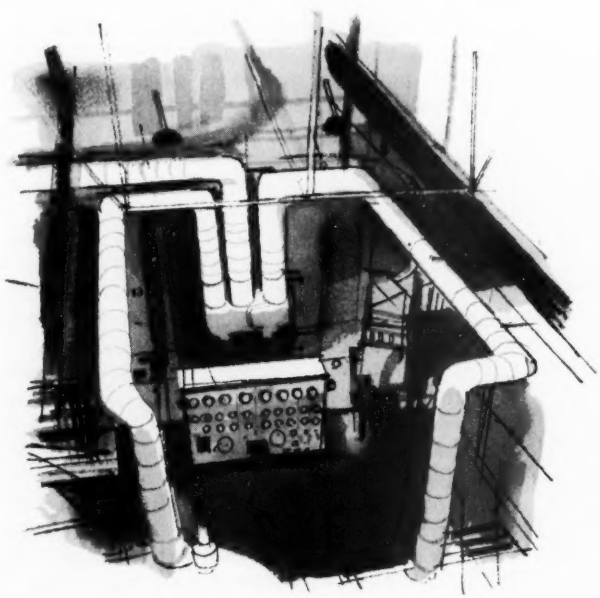
The first officer made coffee with an ingenious contraption in the gyro room, just off the bridge. It was a two-burner electric stove with eight-inch-high tin collars held on with screws to keep coffee pots from tipping over. The collars were gallon cans cut in half and spread to fit the burners. Cups and instant coffee were fitted into a partitioned wooden box affixed to the deck.

"My alarm clock woke me this morning," quipped William Campbell, second assistant engineer, at breakfast. "It fell on me."

Jose Aguilar, the smiling Philippine chief cook who served us, had the agility of a cat as he danced back and forth with scrambled eggs and bacon and steaming coffee. Radio Operator Charles (Sparks) Feinman advised him to pour water on the table cloth to keep our plates from sliding. It worked.

The storm continued most of the day. In the chartroom, I saw a convertible couch turned into a bed with one great roll and slammed back into a couch on the next. During the day, we took in considerable water ballast. Captain Klein ordered the engines slowed from their customary 99 revolutions per minute to 70 to permit the lines (mooring ropes) to be taken in forward. Here was work in the oldest tradition of the sea. Repeatedly drenched by flying spray and having to brace themselves against the severe roll, the men stowed the line. Mariners of a thousand years ago would have appreciated their seamanship, but there the parallel stopped. The line was a giant piece of nylon, eight inches in circumference.

In the afternoon, I paid my respects to the "ship's poet," Pop Benedict. Pop is an oiler whose shipboard hobby is writing poems about most anything. But, curiously enough, he only read me one that was about the sea and that had to do with his retirement which is due in about two years. He seemed to prefer homey subjects like "When the Holidays are Over," and "Your Spring Hat." Twenty years a tankerman, he had been a rail-



roader an equal spell, had run a cement mixer and built highways. "I have a crease on my side from a Mexican bullet when I was with the cavalry fighting Pancho Villa," he noted in reminiscing.

Later, the captain took me on his weekly inspection of the ship. In each cabin, his first act was to run a finger along the top of the fluorescent light above the mirrored medicine cabinet. I noticed he rarely had to wipe off his finger.

"Most of our men are married, have families, belong to the PTA and shop for groceries when they are home on vacations," he commented.

Each cabin had hot and cold running water,

twin lockers, an arm chair and desk, a bed with box springs and an inner spring mattress. Framed glass notices on the walls of the cabins occupied by ordinary seamen outlined work instructions.

By early Sunday afternoon, the storm had ended. On deck I watched the first officer supervising work in No. 10 center tank. There was a crack in the bulkhead which was being repaired with plastic steel. Several crewmen were chipping and painting in the constant battle against salt and corrosion.

Monday found us gliding through blue-green water off the Florida Keys. On our port side was a string of heavily-laden tankers heading north. They were low in the water.

Next morning on the bridge, the captain pointed to a swirling gray cloud ahead. It was a "Northerly," welcomed by seamen as a sign of good weather because it indicates no major disturbance in the atmosphere. In a few moments, we were under it. The water changed from the Gulf's bright blue to dark gray under the black platter-like cloud. Soon we emerged into the sunshine again.

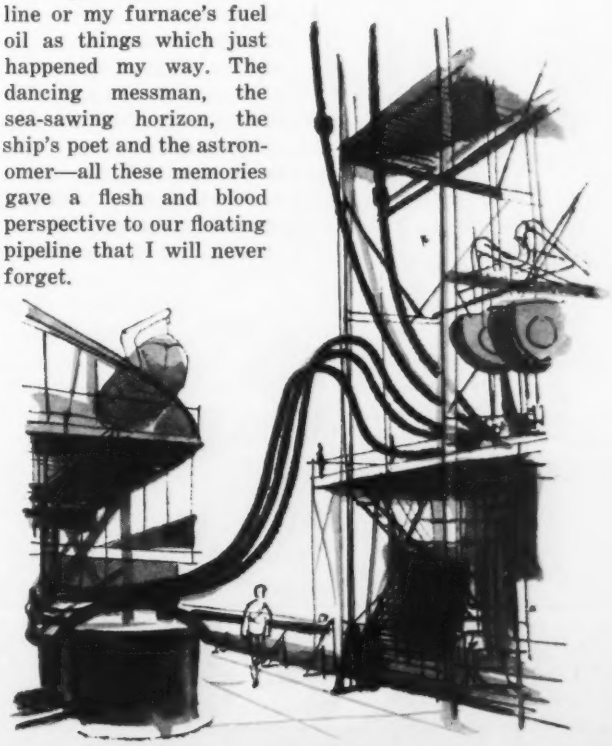
The day's sailing carried us farther into the Gulf and, that night, we passed through a maze of offshore oil rigs strung out in the coastal waters of Louisiana and Texas.

That night, too, the last name was added to the list of crew members entering the ship's "Orange Bridge Pool." Each entrant got three minutes scattered over an hour. The winner would be the one who chose the minute our wheel house passed under the bridge across the long canal that goes from the Gulf up to Beaumont, Texas.

James Mattera, an oiler, won the pool. He was the fourth engineer in a row to win, Sparks Feinman complained disappointedly.

Pilot J. M. Cox waited patiently on the bridge the next morning while we lay fogbound. A cowboy emerged from the haze and rode alongside, herding a few steers. We were inches from the muddy Texas shore. Our ship's bell clamorously broke the foggy quiet every minute. Seamen were making the ship ready for docking, often the most time consuming part of each 18-hour turnaround. Moments after the fog lifted, we were at the pier.

As I left the ship and headed for the airport late Wednesday, one thought stood out in my memory. Never again can I look upon my car's gasoline or my furnace's fuel oil as things which just happened my way. The dancing messman, the sea-sawing horizon, the ship's poet and the astronomer—all these memories gave a flesh and blood perspective to our floating pipeline that I will never forget.



All gremlins aren't

THERE'S a special breed of gremlins getting into all phases of petroleum industry operations nowadays. But, they're as different from the proverbial troublemakers as white from black.

Born in nuclear reactors, these useful gremlins are known as radioisotopes. Turned loose in an oil well, they probe nature's secrets and send back reports. In pipelines and refinery units, they serve as troubleshooters, messengers, inspectors, and are on call for a variety of special duties.

The radioisotope is an amazing atomic particle that science has bred and trained to serve mankind. Its applications range from cancer research to testing the effectiveness of detergents in washing machines.

Here's how the radioisotope got its name: In any given element—hydrogen, oxygen, iron, aluminum, etc.,—there are several closely related varieties of atoms. These varieties are called "isotopes." Some isotopes are stable and do not change with time. Others explode, shooting out radiation or speedy particles even smaller than atoms. Such radiating explosive isotopes are called "radioisotopes."

These particles can neither be seen nor heard, but scientists have developed various detecting devices for communicating with them. Detectors translate radiation that hits them into tiny electric pulses which can be counted.

Scientists learned to prepare radioisotopes in the mid-1930's but, for ten years, they remained expensive laboratory curiosities. The development of nuclear reactors during World War II made it possible to prepare them cheaply and in quantity.

Since the war, compounds containing radioisotopes of one sort or another have been shipped all over the world. They are supplied in the form of powder, in solution or as gasses, and are specially packed to avoid radiation dangers.

Some radioisotopes run their life's course (with most of their atoms exploded) in a matter of days. Most useful types last for months, even years. A few may even last for many centuries.

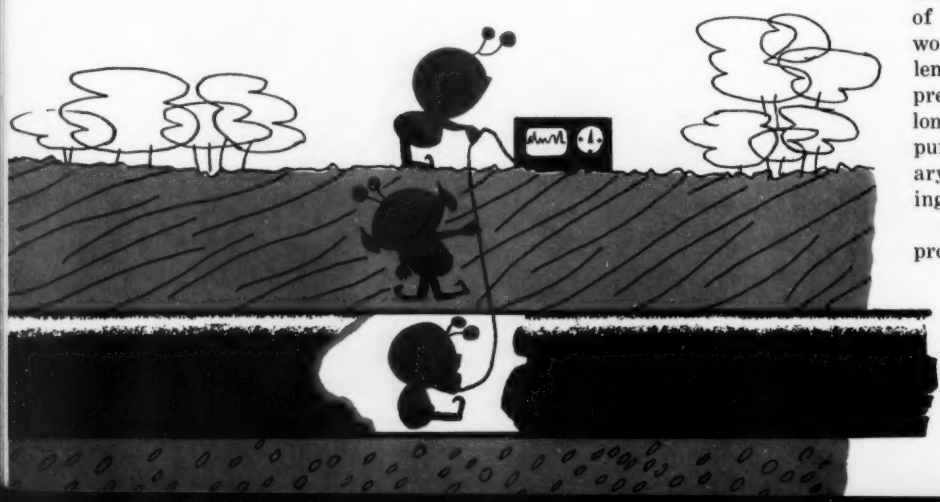
In the oil fields, the little nuclear gremlins do their work in the deep recesses of the earth, and have several different functions.

One is in connection with the frequent use of acid to break downhole bottlenecks during drilling operations. For example, acidizing is commonly employed to dissolve limestone that is hindering the flow of oil. Generally the acid is fed into a well until drillers "guess" the level is high enough to reach the oil-bearing strata. If the level is too low, the acid will do no good. If too high, it is needlessly wasted.

Radioisotopes can eliminate the guesswork in this operation. A detecting device is lowered to the desired depth. Then, the acid mixed with a small quantity of radioisotopes is injected into the well. As the level of acid rises toward that of the detector, a sharp increase in radiation is recorded. This signals engineers to apply pressure to force the acid into the oil-bearing strata.

Fortunately, too, the little nuclear gremlins are proving helpful in secondary recovery methods whereby millions of barrels of oil are recovered that otherwise would be left in the ground. The problem is to revive a field whose natural pressure has fallen so low that it is no longer profitable to obtain the oil by pumping. The most common secondary recovery methods are water flooding and gas injection.

Radioisotopes are used to obtain a profile of underground conditions to



Spotting a pipeline leak.

troublemakers

by Isaac Asimov

guide petroleum engineers in carrying out water flooding or gas injection programs. Water or gas is mixed with an isotope. A counter lowered into a neighboring borehole follows the flow and direction of the isotope and, therefore, the fluid or gas as it makes its way through the underground formations.

Only by drilling a well can the presence of oil be proved. There are no short cuts. But, electronic and nuclear techniques can aid in probing for oil-bearing formations in the course of drilling.

One technique involves mixing a radioisotope with a small quantity of beryllium, which will bring about a continuous emission of neutrons. If such a mixture is lowered down a borehole, the neutrons will bounce off some of the atoms in the material around the hole and other forms of radiation will be given off. From the nature of the radiation produced and the manner in which it is absorbed by the surrounding earth, engineers can determine the chemical makeup, density and porosity of the underlying strata. Oil-bearing formations may be located that have escaped conventional methods of investigation.

Processing industries, notably chemical, have been the major industrial users of radioisotopes. Thus, it is natural that refining was the first segment of the petroleum industry to become a major user.

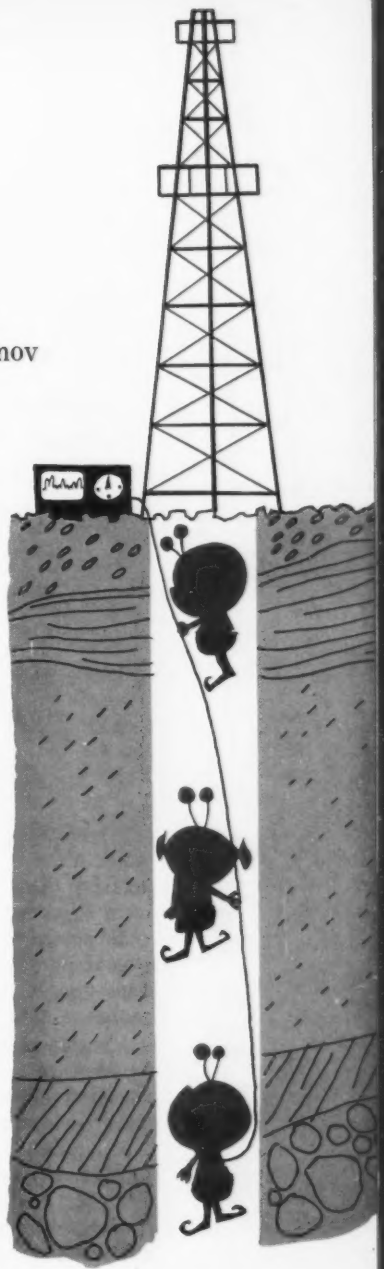
In petroleum "cracking" a process by which gasoline is made from crude oil, small porous beads of catalyst are used to accelerate the operation. Their proper flow through the cracking unit determines the maximum efficiency of the process.

When nuclear gremlins get into this delicate process, they give the proverbial troublemaking gremlins a hard time. They seek out malfunctions and signal the nature of the difficulty. A few catalyst beads are impregnated with a radioisotope. Each one activates a series of counters set along the path of flow.

Whether the rate of flow is at maximum efficiency can be ascertained from the time at which each successive counter is activated. Aside from indicating catalyst flow efficiency, the circulating radioisotopes can determine if flow is being diverted by an unsuspected flaw in the design of the unit, or by an accidental leak or blockage.

The radioisotope actually serves as an automatic control mechanism in refining operations. Take the case of a reaction vessel that is most efficient when its liquid content is at a certain level. A capsule containing a radioisotope can be placed on one side of the vessel at the desired level, and a counter placed directly opposite on the other side. Radiation emitted through an opening in the capsule streaks through the walls of the container and registers on the counter. Some radiation is absorbed by the walls but a fixed percentage gets through so that the count level remains steady.

If the liquid in the vessel rises to cut across the line of radiation, the count goes down. The sudden drop activates a device that will reduce the rate at which the liquid flows into the vessel. Conversely, when the liquid level goes below the radiation line it increases the count and sparks an increased flow.



Probing an underground formation.

Radioisotopes are also used to measure the thicknesses of solid petroleum products such as asphalt sheeting. As the sheeting is formed, it moves between a radioisotope capsule and a counter. A perfectly even thickness absorbs the same small fraction of radiation and the count level remains steady. But a thin spot lets more radiation through and the count jumps. Conversely, a thick spot reduces the count. The detection device can be

attached to controls that automatically correct the flow of asphalt.

Flaws in metal itself—pipelines and refinery equipment—can be detected by the same method. Thin spots or the presence of air bubbles will let through too much radiation, causing a jump in the count level. Portable radioisotope gages have been developed to test pipelines in the field. Here, radioisotopes are actually used as a type of X-ray.

In pipeline operations, both tracer and radioisotope capsule-counter techniques are used to identify a passing interface. (A small area of mixture of two products, one following the other—like gasoline and diesel oil.) Ordinarily, the position of interfaces is checked by taking samples at various points along the pipeline. This is tedious and expensive.

By placing a radioisotope capsule on one side of a pipeline and a counter on the other, "light" and "heavy" batches can be identified. Gasoline, a light product, will let more radiation through while a heavier product like diesel fuel will block out more.

In the radiotracer technique a small quantity of radioisotope is added to the new product the moment it enters the pipeline. The radioisotope marks the interface, which counters monitor at strategic points along the pipeline route.

Tracers are also valuable in finding leaks in pipelines. A smaller quantity of oil-soluble material containing a radioisotope is allawed to trickle into the pipeline along with the crude oil or product. At the point of the leak, the soil surrounding it will contain tracer that gives off radiation which can be detected. The tracer saves digging up as much as several miles of pipe.

In the laboratory, radioisotopes have become valuable new research tools. Take, for example, lubricant efficiency tests. Previously, a moving part with a sample of lubricant was run until enough metal was worn away to change the part's measurement. The greater the wear, the less efficient the lubricant. Naturally, this took a long time and the engine containing the part had to be painstakingly dismantled for testing again and again.

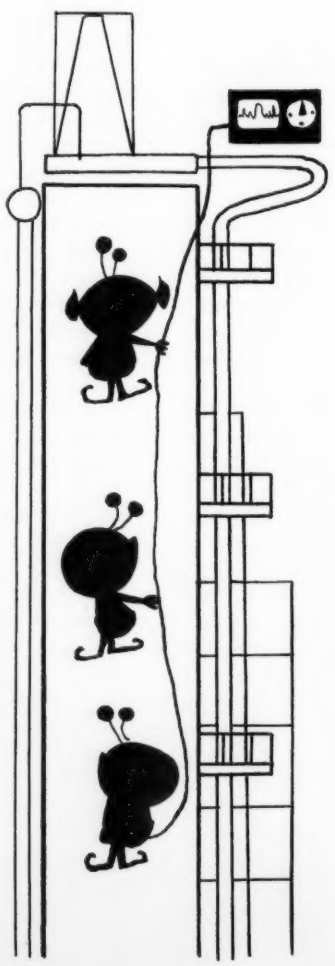
Thanks to the nuclear scientist the moving part can now be impregnated with a small amount of radioisotope. As it wears away under operation, microscopic fragments of the part—including the isotope—enter the lubricant. The radiation from the fragments in the lubricant is continually counted. From this information, the amount of wear during various stages of engine operation is calculated—all within a short period of time and without dismantling the engine.

Tests to determine the rate of formation of carbon deposits on working engines also have been shortened by days and weeks. A dose of radioisotopes is added to the gasoline and lubricating oil used in the engine. Any of the gasoline and oil that is converted into carbon deposits carries a certain amount of the radioisotope. The amount of deposit and its exact position can be located by the counter.

An alternative method is to incorporate a radioisotope into those engine parts which collect deposits. As a film of deposit forms, it blocks off some of the radiation emitted by the part. The drop in count level will give the needed information.

Only the surface has been scratched in radioisotope applications. But already the petroleum industry, eager to take advantage of technological breakthroughs, has widened its nuclear horizon. It is conducting intensive research in the potential use of high-intensity radiation as a processing agent. If radiation from large quantities of radioisotopes or nuclear reactors can be harnessed, it could be employed to induce chemical reactions, effect catalyst efficiency, sweeten crude fractions and polymerize materials.

Indeed, the little gremlins from the nuclear reactors may some day just run the show.



Troubleshooting in a refinery unit.

New era for an ancient product

by Bruce Quayle

Asphalt has served man well in the 60 centuries since it was used to caulk Noah's Ark. Now modern research is providing a host of exciting new uses for the material that covers 90 per cent of our roads and 6 out of 7 roofs.

Before we Americans start mass flights into space, some easy way must be found to protect us against cosmic radiation. This may be at hand.

Our financially-pressed railroads certainly could use a new maintenance technique that would save a quarter billion dollars a year. One is being tested.

In semi-arid regions of the world, agricultural researchers have long sought a low-cost means of building leakproof irrigation ditches. A solution has been found.

The common bond between these developments and many other exciting examples of U.S. Progress 1960 A.D. is the oldest petroleum product in the world—asphalt, circa 3800 B.C.

The material that the book of Genesis tells us caulked Noah's Ark and held together the Tower of Babel has taken—at age 6,000—a new lease on life. Twentieth century men are realizing what is recorded in the earliest pages of western history —that the sticky, dark substance known as asphalt (or asphaltum, bitumen, pitch, tar and slime) is a material of uncommon versatility.

To the Sumerians, Assyrians and Babylonians, who dwelt where oil rigs now dot the countryside, asphalt was many things. It was "cement" for binding bricks together. It was waterproofing against the frequent floods. It enabled baskets to contain liquids (or, fortunately for Moses, to keep them out). Roads were built with asphalt. Internally and externally, it was a potent and highly esteemed medicine. It was richly used in the arts. Asphalt was even a keeper of the peace—Assyrian law decreeing that for certain crimes hot asphalt should be poured on the offender's head.

About 600 B.C., the ancient asphalt technology began to fade. The conquering Greeks had little interest in it, and the Romans who followed were masters of stone, mortar and wood. Despite early discoveries of natural asphalt in the New World, there was no great interest in its use.

Even the birth in 1859 of the U. S. oil industry, now the major source of our asphalt, created little immediate interest in its domestic use. In fact, the asphalt first generally used in this country, late in the 19th century, came from abroad.

Thus, for all but a short time in asphalt's long history, the only source of the material was in natural deposits scattered throughout the world. These are plentiful, yet, like crude oil, of varied composition. The Biblical asphalt of what is now Iraq was found associated with mineral matter.

The same sort was found in the famous Pitch Lake of Trinidad, probably the largest deposit of natural asphalt in the world. Rock asphalts—which are actually rocks impregnated with asphalt—are found in Europe, Canada and in a number of our states. The only natural deposit that is pure asphalt is the noted Bermudez Lake in Venezuela.

Asphalt was first used in this country in 1870 when a supply from Trinidad was brought in to pave the street in front of the Newark, N. J., City Hall. Six years later, Congress called for the surfacing of Pennsylvania Avenue in the nation's capital—a job done partly with French rock asphalt and partly with material from Trinidad.

It wasn't until after the turn of the century that refined crude oil became a significant source of asphalt. Today, petroleum asphalt supplies over 92 per cent of U. S. needs, the balance coming from natural deposits here and abroad.

Refiners refer to that portion of crude oil yielding asphalt somewhat disparagingly as the "bottom of the barrel." And, as a matter of fact, they devote intense research efforts to reducing the amount of "barrel bottom" products they produce, for the logical reason that in other forms—gasoline or heating oils—this material is worth more in the market place.

However, this by no means condemns asphalt to the status of an unwanted orphan among the products of a barrel of crude oil. Far from being the by-product that its "bottom of the barrel" label might indicate, modern asphalt is the result of exacting processing methods and is turned out with the same loving care devoted to the best premium gasoline. Moreover, while some researchers in effect are striving to strangle asphalt at birth, other equally devoted scientists are striving just as hard to develop new uses for it.

Asphalt consequently has become a growing "family of materials." But, of course, the family portrait is dominated by the breadwinners of the tribe—the road asphalts.

It is hardly news that road construction accounts for 75 per cent of the country's asphalt consumption or that some 90 per cent of all U. S. paved roads are asphalt surfaced. Many years have elapsed since asphalt first got America out of the mud and made motoring more than a dusty pastime. Asphalt roads are an old story.

The second largest use of asphalt is in keeping the proverbial roof over our heads. Unless you are reading this out-of-doors, chances are 6 in 7 that you are under some form of asphalt covering.

Newly-developed techniques of manufacturing the colored granules which combine with asphalt in roof shingles—and siding—are lifting the architectural horizon for this durable, yet economical construction material.

Where hurricanes have blown whole roof structures off, the shingles have remained in place. One new development is a special adhesive that takes hold only after the shingle is exposed to the sun. Another is a unique interlocking design that hooks one shingle into its neighbor.

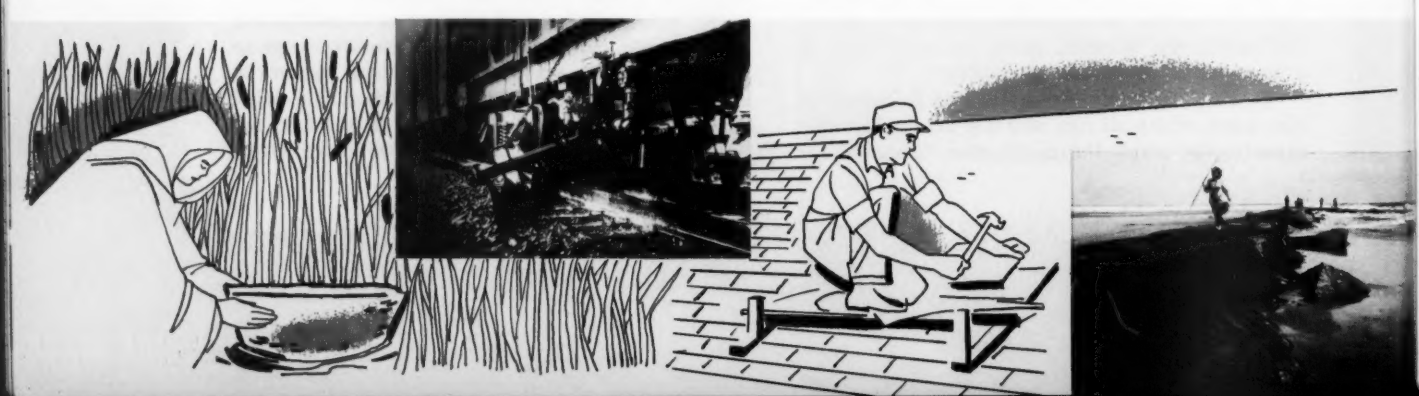
"Self repairing" roofs are yet another product of asphalt research. These are the flat, or built up, roofs employed on industrial and commercial buildings. In association with felt layers, these roofs are now put down with an asphalt that softens and flows under the sun's heat, thus healing any small cracks that develop due to contractions, expansion or minor movements of the building.

Roof asphalts, in fact, are tailor-made to climatic conditions and types of buildings. House shingles, which seldom lie flat, must be particularly softening-proof, or the whole roof would end up in the yard.

Along with these revolutionary changes in road-and-roof asphalt products has come a wide-variety of new and potential applications of the age-old substance.

Along the Atlantic seaboard, asphalt jetties (or groins) promise an economical remedy for the perennial headache of coastal erosion. At Ocean City, Md., Harvey Cedars, N. J., Fernandain Beach, Fla., and other locations, jetties costing a fourth as much as timber, steel and rock structures, are halting the remorseless gnawing of the sea. At Ocean City, 43 low-profile groins have proved an unqualified success in calming the sweeping waves that threaten the famous beach there.

In semi-arid regions of the west, as much as



33 per cent of the irrigation water is lost in passage from reservoir to point of use when carried through unlined canals and ditches. Seepage also makes soil more alkaline, reducing its productive capacity. Waterproof asphalt membranes and linings have been found highly effective in halting water loss.

The newest technique in water preservation uses prefabricated, asphalt-coated burlap sheets to line irrigation ditches. Tests begun last August in Utah by the federal Agricultural Research Service indicate the liners will provide the economical, yet durable means that farmers need to open up new areas to cultivation. In the tests, liners are coated on both sides with asphalt and joined simply by heating and pressing together.

Such techniques for increasing the effectiveness of irrigation at low cost could bring far-reaching economic benefits to underprivileged countries throughout the world.

Hopes for another fascinating farm use of asphalt are growing out of experiments with its use as a moisture-holding film applied directly over fields and seed beds. The film is designed to forestall moisture evaporation during the vital germination period, after which the plant pierces the covering and grows naturally. Easily and economically applied, the asphalt covering also is a potential protective blanket for dust bowl areas, keeping the soil cover in place in dry season.

Another moisture conservation technique with asphalt involves laying out waterproof strips across the surface to concentrate and channel scarce rainfall into useful areas and prevent it from soaking wastefully into the ground.

Asphalt has gone to work on the railroads and may be the answer to a hard-pressed treasurer's prayers. Tests made by the Santa Fe Railroad indicate that spraying asphalt on track ties and ballast may save as much as $1,000 a mile in annual maintenance costs. The asphalt reduces to a minimum the water infiltration which shortens ballast life. It reduces splitting and checking of wooden ties. The Santa Fe experiment was begun last summer, and this year, according to The Asphalt Institute, the Norfolk and Western Railroad plans to conduct similiar tests.

The nation's Class I railroads cover some 250,000 miles. It takes only simple arithmetic to realize what an annual saving of $1,000 a mile would mean in keeping America's vital rail network financially healthy.

Asphalt has also been used by one railroad as a "paint" for protecting its metal bridges, with great savings in time and money. Atomized asphalt is sprayed hot onto the metal in half the time it takes to apply two coats of conventional protective paint. The cost: 21 cents a gallon for asphalt as against $2.85 for paint.

And the list of new uses grows steadily.

Entomologists at the University of California are testing asphalt impregnated with insecticide as an underlayer for home foundations to guard against the costly entry of termites.

In New York City, garbage scows are being lined with asphalt to give them longer life.

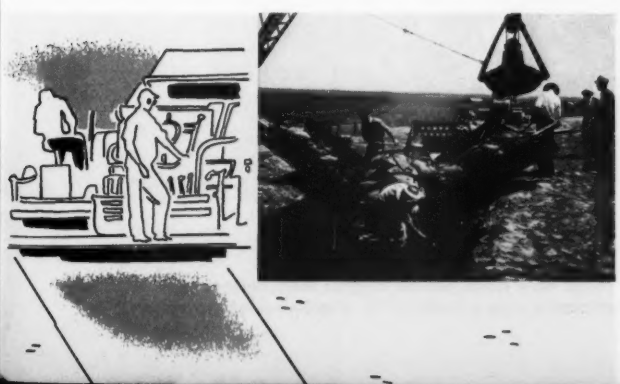
Architects looking for new ideas are falling back on what is really an old idea and using asphalt blocks for decorative walkways and sidewalks. Pittsburgh's ultramodern Gateway Center, New York's jet-age Idlewild Airport and Detroit's Civic Center are outstanding examples.

The black magic material shows up in the darnedest places: clay pigeons, brake linings, tires, paints, upholstery, inks, electrical insulation, pipe coatings, dressings for tree surgery, disposable flower pots, paper bags, waterproof tennis courts and running tracks, auto battery cases, auto undercoating, ship and yacht bottoms, waterproof papers, and on and on.

No wonder the last decade has seen asphalt use doubled — from ten million tons in 1949 to 20 million tons last year. And reports of new asphalt plants under construction confirm the confidence that such growth will continue into the Fabulous Sixties—and undoubtedly beyond.

Certainly the sky is not the limit if what one space scientist has suggested comes about. Tomorrow's space traveler faces, among many problems, the bombardment of cosmic rays on his journey. A University of Maryland professor points out that a thin shield of petroleum would absorb such rays harmlessly, and he agrees with an Asphalt Institute "brain stormer" that asphalt would do as well as any other petroleum product. So the fashion note for 1975 may be asphalt impregnated space suits for the well garbed vacationists along the canals of Mars.

It could happen, for asphalt has been amazing people for more than 60 centuries.



THE CHANGING VOICE OF THE "CHOO-CHOO"

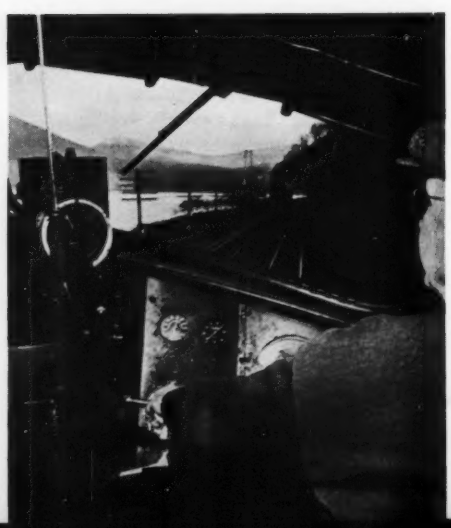
Diesel locomotives put in more running time than their steam-driven predecessors before having to pull into a railroad "service station."

"The diesel engine means great things for American railroads, and even greater things are coming."

No finer compliment could be paid the new look on the nation's railroads, because it came from a veteran steam locomotive engineer whose iron horse had just been forced into retirement by a diesel engine. And more to the point, his was the last U. S. steam locomotive in regular service on a major railroad.

The date was March 27, 1960, and it marked the end of an era. The familiar "choo-choo" sound on America's rails has given way to the claxon air horn of the diesel.

Steam was king of the rails for more than 120 years. The era opened with the experimental *Tom Thumb*, built by Peter Cooper in 1830, and the *Best Friend of Charleston*, which pulled the first train in regular service that same year. Steam drove thousands of engines millions of miles, opening a continent, lacing up a lot of geography, binding together a nation. Casey Jones;



The engineer's job is easier on a diesel and he controls more horsepower. Throttle regulates electric-drive motors supplied by diesel-powered generators.

the Golden Spike; The Little Engine That Could; Run into the Round House, Nellie; the steam whistle in the night—these are the memories of an age.

But, as the engineer said, the diesel engine means great things. And so it must, for in less than 30 years it toppled King Steam and has all but driven him from the rails. The dwindling number of steam engines still in use on smaller roads and as standbys represents only five per cent of the nation's locomotives. The last steam engine was ordered in 1952.

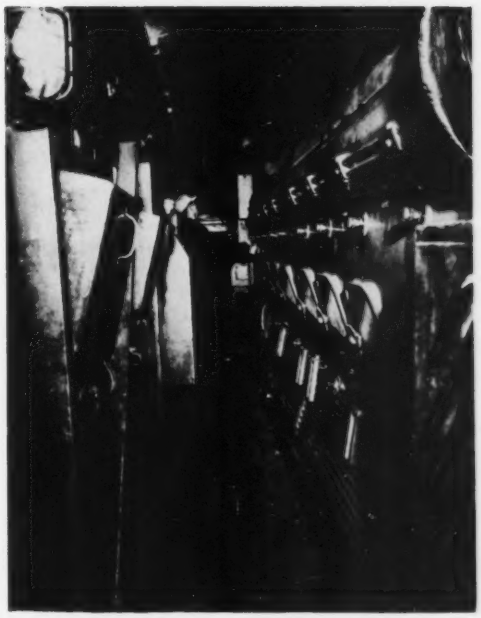
The first diesel engine—a switcher on the Jersey Central—went into service in 1925 (and into a museum in 1957). Just ten years ago, about 14,000 diesels were in service and now, more than double that number are working on the railroads.

The trend to diesels was inevitable because of their greater power and efficiency, and easier and more economical maintenance. A single diesel engine can be used for a trip from Chicago to the Pacific Coast, and between runs it needs practically no servicing—just fuel, lubricating oil and water; like your automobile.

Properly speaking, the diesel engine doesn't drive the train. It turns a generator which produces current for electric motors, and these turn the wheels.

"Even greater things are coming," said the engineer. Possibly he meant the turbo-electric engine which operates on the principle of a prop-jet airplane. This is being tested on rugged western mountain runs. Possibly he meant the dual fuel engine now being tried out. This burns diesel oil to get the engine going and then switches to less expensive residual oil.

But who knows, someday a veteran diesel engineer may climb from his cab and say, "The atomic locomotive means great things . . ."



Firing up the engine now means pushing a button, not shoveling coal. Keeping a close check on mechanical equipment is one of the fireman's chief duties.

Typical quick turnaround finds refueled diesel ready to start a new new run. It is one of more than 28,000 now in service on U. S. railroads.

Powered by an internal combustion engine similar to that in an automobile, the diesel locomotive is as easily overhauled.

"Fill 'er up" for this diesel means 1,200 gallons. Railroad demand for diesel fuel tripled in ten years, totaling about 3.6 billion gallons in 1959.

THE WITCH

by Robert W. Stock

THEY call it "the bird" or " the maggie." It was once mistaken for the atom bomb. Kentucky moonshiners and African natives have used it for target practice.

The silvery, torpedo-shaped object is the airborne magnetometer. It plays a vital role in keeping the world supplied with low-cost petroleum energy. Men have suffered and died in its service.

Strung out behind a plane at the end of a 150-foot cable, the maggie picks up and records the most minute magnetic variations of the giant magnet which is the earth. The variations correspond to differences in the composition and structure of rocks near the surface. Thus the wiggly lines drawn upon graph paper high in the air provide clues to the subterranean geology of the ground below—and thereby to the possible presence of oil deposits.

As you read this, an airborne magnetometer is skimming low over the Appalachian Basin, as part of a year-long, 121,500 square mile survey which brings the story of oil in America full circle. The first commercial petroleum production in history came out of this same area just 100 years ago last August.

Oil exploration techniques have undergone some changes in the century since Colonel Edwin L. Drake drilled the first well at Titusville, Pa. The favorite petroleum-finding device of his day was a forked branch from a witch hazel tree—the so-called "witch" that worked like a dowsing rod. Men whose arthritis kicked up in the presence of

A torpedo-shaped magnetometer on a 150-foot cable picks up magnetic variations to chart subsurface rock structures as a guide to ground surveys by oil geologists.

THAT RIDES HIGH

oil achieved great popularity. And one Abram James depended upon the services of "Lalah, The Spirit Guide," who sent him spinning over a potential oil deposit. The progress achieved by the industry in the past century is well symbolized by the contrast between the forked branch and the airborne magnetometer—the witch that rides high.

The maggie has had a strange and wonderful career over the past two decades. It started in an oil company laboratory. With the advent of World War II, it was taken over by the Navy as a potential submarine detector. The U. S. Geological Survey borrowed the bird for iron ore exploration. In the summer of 1945 it made its first oil exploration flights in Alaska. Since that time airmags —and airmag men—have seen service in some of the most desolate and forbidding regions of the earth. And the maggie now rides on a plane's wing tip or tail as well as at the end of a cable.

Homer Jensen is at 46 years of age one of the elder statesmen in the airborne magnetometer field. A pilot, physicist, photographer, inventor, Jensen directs airmag operations for one of the world's leading aerial survey organizations. During the past decade he has traveled an average of 300 air miles a day.

Jensen started working with the maggie in 1943 when the Navy conducted secret experimental flights in the scrub pine country south of Jacksonville, Fla. Object of the mission was to locate a simulated submarine in the form of a big coil of cable.

The military placed great stress on the confidential nature of the device. For one series of

Homer Jensen, pioneer in the airmag field, inspects the delicate mechanism of a new type wing-tip "maggie." In the last decade, he has averaged 300 air-miles a day.

tests, Jensen placed a piece of reflecting plastic over the bird, leading civilians to assume the instrument was a camera. He recalls a demonstration in Oklahoma when the airmag was lost in flight. "The Navy mobilized," he says. "Hundreds of men searched the area for weeks. Finally a farmer brought in a box which contained 80 per cent mud and 20 per cent airmag parts."

Jensen's experiences with the bird in Alaska were typical of the hardships airmag men endure. Flying conditions were hazardous at best, with visibility poor and landing fields primitive. "We used to say if you held up your hand in front of your face and you could see it, you could fly. Or if you kicked a seagull in the rear and it moved, you could take off." Jensen once had to spend the night in a flying boat after making a close-to-blind landing between ice floes.

With the end of World War II, the bird was adopted for commercial use. The research put into it by oil scientists paid off in petroleum exploration; but the steel industry reaped benefits as well.

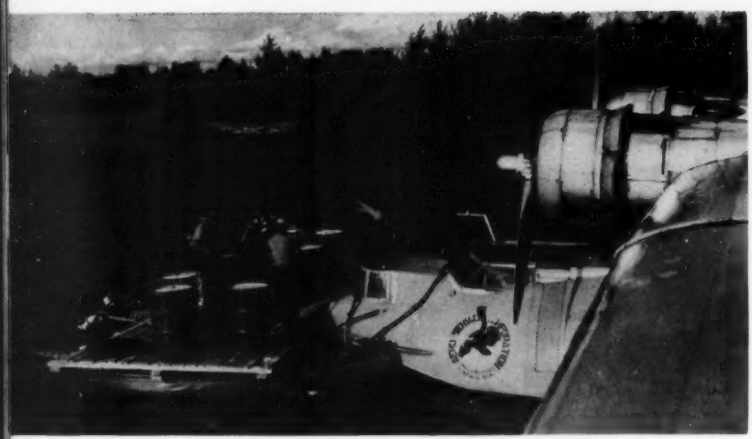
There is a basic distinction between the results the two industries obtain from an airmag survey. In the case of iron ore, the bird provides solid indications of the presence of a deposit. It has performed the same service in locating sunken ships. In the case of petroleum, the airmag is an indirect aid.

Despite the expenditure of millions of research dollars, no direct oil-finding tool has ever been developed—except for the drilling bit itself. But drilling is expensive, and dry hole failures are frequent, so oilmen will go a long way to find out as much as they can about a potential deposit before they raise a rig.

One technique involves setting off small ex-

With the aid of an electronic navigational device, air crewmen can pinpoint a survey plane's position and chart a flight course over dense jungles and vast deserts.

High on the monkey board a derrickman stacks pipe used in core-test drilling.



Airmag crews survey some of the most desolate and forbidding regions of the world. Here, a plane is being refueled on a backwoods lake from canoe-borne drums.

plosives and charting their progress underground with seismographs. Chemical studies of samples of surface earth are conducted. Sound waves and electronic impulses are used to gain information about subterranean geologic conditions. What the airborne maggie does is to pinpoint those areas in a large and often impenetrable tract of land where on-the-spot exploration techniques may pay off. Every square mile it eliminates represents a saving of $1,000 in ground survey costs.

In the process of gathering its data, the maggie has often been suspect. Homer Jensen and his colleagues have found the device an uncomfortable traveling companion.

"One time we had a crew down in South America," Jensen recalls, "and they landed at a small town. We'd been told by the government everything was okay, but when the plane came into the little airport there was a bunch of soldiers with rifles waiting. Seems there'd been a revolution while our boys were up in the air."

The airmag men were held in the local hotel for days. Their luggage remained under official protection, so they did without razors, toothbrushes and fresh clothes. At last, they were allowed to start the survey, with the proviso that they have a government observer on each flight. A local newspaperman had sized up the airmag as an atom bomb, and the natives didn't want to take any chances.

The sinister appearance of the maggie has caused it to be shot at in Kentucky and Arabia. African natives have tried to spear it. But the greatest tribute was paid by a group of frightened natives on the east coast of Nicaragua. When they saw the plane and its trailing bird, they waved white surrender flags.

Such incidents have been rare in the millions of survey miles flown. Jensen assigns more weight to the every-day dangers and hardships. "We fly pretty low, down as far as 300 feet for mineral surveys, and we're more worried about sudden cliffs and air currents than spears." The bird, itself, has a tendency to whip around on its cable —Jensen remembers one flight when it stove in the side of the plane. And the landing strips are not just unimproved but "unimprovable."

"We had some men looking over Costa Rica before a survey. Solid jungle. Then one of them saw a good stretch of beach below. He told his buddy, 'Let's remember that in case we ever have to land.' Turned out to be their base field."

In remote areas without landmarks, airmag men establish and man Shoran stations, electronic installations used to give pilots a fix on their aerial positions. Most stations are on mountain tops or elevations, deep in unexplored terrain, and must be reached and supplied by helicopter.

"The men in the air may face the more obvious dangers," says Jensen, "but the Shoran boys have to be really tough." Living conditions are primitive in the extreme. They spend months on duty in areas ranging from desert and jungle to the Arctic. And they have to keep their eyes open. Asian bandits murdered one man in his sleep. His companion had gone down the mountain for supplies.

Jensen doesn't like to talk about these aspects of surveying. "They're the exception," he says. "Why don't you ask me about what we're doing now?"

The latest project for his firm, only one of several airmag surveys they have underway, is the Appalachian Basin job. When it is done, the maps based upon magnetic findings will be offered to petroleum companies. There has been some oil production in certain sections of the Basin ever since Colonel Drake's day. It currently amounts to about 16 million barrels a *year*, a mere drop in the bucket for a nation consuming almost 10 million barrels *daily*. But geologists, and oilmen, have hopes that there are large untapped pools of petroleum which the witches and spiritualists of a century ago overlooked.

At the very least, there won't be any spears to duck on this latest of aerial oil hunts.

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